Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

OCTOBER, 1913.

DARK-GROUND ILLUMINATION AND ULTRA-MICROSCOPIC METHODS IN BOTANY.

By S. REGINALD PRICE, B.A. (CANTAB.)

During the last few years, and more especially since the introduction of the ultra-microscope in the early part of the century by Siedentopf and Zsigmondy, the application of methods of dark-ground illumination to high-power work has received much attention, while many interesting and important observations have been made by the use of the methods. The work which has been done in botanical research is probably comparatively little known, but nevertheless the method seems likely already to become an important one in studying various aspects of the plant cell and also in other directions indicated below. The results, moreover, are of general interest to the biologist as well as to the specialised plant physiologist, and, in view of this, a short account of some of the observations already made may be of sufficient interest to justify this article.

Only a very brief account of methods can be given here, and at the outset it must be emphasised that a distinction must be made between methods of dark-ground illumination and the method of the ultra-microscope. The latter term is best confined to the method devised and used by Siedentopf and Zsigmondy—the illumination of the object (coloured glass, colloidal solutions, and so on) by a lateral beam of light, perpendicular to the optical axis of the microscope.

Dark-ground illuminators are sometimes also called ultra-microscopes, but this terminology should not be used, although it is true that at times they can render ***visible***, particles which are below the limits of visibility in direct illumination.

An apparatus for demonstrating ultra-microscopic particles is always a dark-ground illuminator, but the converse does not necessarily hold. Certain forms of sub-stage illuminators are now on the market, which give a very intense concentration of the light in a small area, and these are chiefly used for studying ultra-microscopic particles. Such are the Cardioid condenser of Zeiss and the Ultra-condenser of Leitz. Possibly the term "ultra-microscope" should not be applied to these, if it be desired to keep a special name for Siedentopf and Zsigmondy's apparatus, but Leitz's term "ultra-condenser" would be suitable.

It is important to notice that most of the high-power dark-ground illuminators, do render visible ultra-microscopic particles under certain conditions.

For further particulars the pamphlets of Leitz and Zeiss should be consulted, as well as works on the microscope, which, however, will not include

XUM

descriptions of some of the later designs of apparatus, although they will deal with the theory of dark-ground illumination in general.

The most general methods in use are as follows:—

(1) Siedentopf and Zsigmondy's Ultra-microscope, which, however, is inconvenient in biological work, although it has been employed at times.

(2) Sub-stage Dark-ground Illuminators.

The simplest type is the central stop in the immersion condenser of high N.A., which, however, is strongly chromatic.

The simpler forms of dark-ground illuminators, such as the paraboloid of Zeiss and reflecting condensers of most optical firms, are primarily designed for fine dark-ground structural work such as the observation of bacteria; but, as mentioned above, with a bright source of light they render visible ultra-microscopic particles.

The ultra-condenser of Leitz, designed by Dr. Jentzsch, and the cardioid condenser of Zeiss, by Dr. Siedentopf, are both primarily designed for ultra-microscopic observations, but are not very suitable for biological work on account of the delicacy of adjustment required.

In most of the dark-ground illuminators the rays fall on the cover-slip at such an angle that total reflection takes place, so that a clear field appears black. When objects are present they shine out brightly by the light which they scatter.

In using immersion objectives, special means must be taken to reduce the aperture—that is, to cut out the peripheral rays by means of a diaphragm. Apochromatic objectives always give the best results, and the illuminators themselves are usually achromatic.

(3) By stopping the objective.

This method was also devised by Dr. Siedentopf. A certain circular area of the centre of the front lens of the objective is blackened at the back. A condenser of low N.A. is used and stopped down till the direct cone of light is just blocked by the blackened area. When objects are introduced into the field they scatter the light. The method is chiefly used for thick preparations, but has the disadvantage of showing strong diffraction rings.

With regard to the illuminant, in most cases the better the light the better are the results. A Nernst lamp gives fairly good results with the paraboloid, for example, but more especially for the dark-ground structural observations. A small arc lamp is better, but best of all is strong sunlight directed on to a large glass globe filled with water, although this light cannot always be switched on when required!

Such is an indication of the methods employed. A short list of literature will be given at the end. The study of living material is usually most instructive, so that in most cases water has to be used as the mounting fluid.

. . . . . .

A few of the applications of the method in botanical work will now be shortly described. Little will be said of the work included in the first two classes below, as many of the observations are mostly of interest to the specialist alone. The main lines of work may be perhaps classified as follows:—

(*a*) The study of living bacteria, and so on.

(*b*) The study of moving cilia.

(*c*) Observations of the living plant cell.

(*a*) Little will be said here. The method has been useful in studying bacteria in the living state generally, especially when one dimension is sub-microscopic. The presence and movement of the flagella have also been observed in the living state.

(*b*) The method greatly facilitates the study of cilia generally, as these are easier to observe as a bright line against a dark background than in direct illumination.

Ulélah has recently published his results of a series of researches by means of the method; he used, in fact, a Zeiss paraboloid. Motile cells from practically all the great groups were examined—zoöspores of green and brown Algae, spermatozoids of Bryophyta, and so on, as well as many Flagellata. The results are, of course, to be appreciated by the plant physiologist, but generally the work is of interest in showing that the method is capable of profitable application in this direction.

(*c*) It is, however, with regard to the structure of the plant cell that the most important results have been obtained.

The method of illumination employed, demonstrates the presence of structures and particles which cannot be observed in direct illumination, and it also renders much more distinct some particles which on account of their transparency and small size are very difficult of observation in direct illumination.

The greatest difficulty to be encountered in the application of the method to the study of the plant cell is that of choosing and obtaining suitable material which can be examined in the living state. The object must, if possible, be only one cell thick, which at once precludes the use of masses of tissue, or sections of tissue generally. The cell walls must be optically homogeneous, or nearly so, in order to allow of an illumination of the cell contents, and, moreover, the outer wall of the cell must be quite clean. When all these desiderata have been obtained the cell contents may be quite unsuitable—for example, a large peripheral chloroplast scatters most of the light at once, so that no internal cell structure can be seen.

Objects which may furnish suitable material are more especially unicellular organisms, such as unicellular algae, yeasts and so on, filamentous Algae and Fungi—*Spirogyra*, *Mucor*, flat plates of cells—*monostroma*, thin leaves, unicellular or seriate plant hairs, root-hairs, and so on. There is still another point which rapidly becomes evident when observation is begun—the cells must not be too small nor the

filament too narrow, or the diffraction images of the edges mask all other effects.

Much of the work in the observation of the living plant cell has been done by N. Gaidukov (see his "Dunkelfeldbeleuchtung" reference at end).

A few general examples of some of the best objects for observation and the appearance they present may be described, and in many cases the first appearance is sufficiently surprising. One of the most suitable objects for observation is the green alga *Spirogyra*. A species with fairly thick filaments and a rather loose spiral chloroplast is best, but a close spiral does not prevent good observation, and, in fact, in some cases may be an advantage (Price, S.R.; see references below). A single filament is mounted in water and covered with a thin cover-slip for observation. Under quite a low power of the microscope of, say, two hundred diameters in good illumination a large number of twinkling points of light with a rapid dancing motion first attract the attention. These are particles which occur in the cell sap and may conveniently be referred to as "sap-particles." They can usually be seen in illumination under high powers, especially with the condenser considerably stopped down. Little attention as yet seems to have been given to these particles, which are apparently widely distributed in plant cells. They seem to increase in number with a lowering of the plant's vitality.

Under high power, say the three-millimetre apochromat of Zeiss, and a six or twelve compensating ocular, much more can be made out. The chloroplast is relatively inconspicuous now, and the protoplast, which lines the wall of the cell and encloses the sap vacuole, is seen to be full of rapidly oscillating and moving particles of a minute size, particles which are not seen in direct illumination. There is some evidence to show that particles of two orders of magnitude are present, the smaller particles being present in the internal and external layers of the protoplast. On focusing in a lower plane—into the vacuole—the sap particles can be seen again, and now they appear rather as minute bubbles of a refracting liquid of a greater order of magnitude than the protoplasmic particles. In a few cases the nucleus can be seen, appearing almost clear and suspended by protoplasmic fibrils in which are moving particles.

The whole appearance is certainly very striking and animated, and gives rather a new impression of the great activity of the living cell.

Incidentally, a dead cell shows none of the protoplasmic movement, and the coagulated protoplast has quite a different appearance.

The staminal hairs of *Tradescantia* have also been observed by Gaidukov and show somewhat the same phenomena. The cell wall is finely striated, however, so that observation is not so easily made. The circulation and streaming of the protoplasm can be well seen.

The latter is also particularly well shown by certain cells in the leaf of *Elodea*, the American water-weed, so common in our waterways. A single leaf is removed and mounted in water. The leaf is only one cell thick at the edge, and, moreover, the chloroplasts are relatively few in these cells. At first only the "sap particles" may be seen, but with careful observation the protoplasm can be observed filled with minute particles, exhibiting a rapid oscillating or Brownian movement. As the leaf warms up the streaming of these particles along the protoplasmic threads and round the cell is clearly seen. After a time a well-marked rotation of the protoplasm is set up, and the minute particles seem to travel along at a great rate. Subsequently enough energy seems to be developed to cause the chloroplasts to move, but these always do so at a slower rate than the small particles.

Somewhat similar phenomena, the Brownian movement of the small particles in the protoplasm, and so on, have been described for many other objects; for example, *Mougeotia* cells, root-hairs of mustard, yeast cells, multicellular hairs from the tomato plant; but, as would be expected, there are differences in detail. Yet other cases seem to show little or no movement of the protoplasmic particles.

The extreme mobility and the great display of activity in some of these plant cells seem at first sight rather surprising and rather militate against some of the older views of the structure of the protoplasm of the living cell. Although the observations yet made are comparatively few—too few to admit of any elaborate theory being postulated—yet some sort of hypothesis is required to explain these phenomena, to be used as a basis for further analysis. The facts as they appear at present seem to agree quite well with the hypothesis that the protoplasm is of the nature of a colloid solution, and in view of recent work on colloids in other directions this view is considerably strengthened. The particles which have been described above are held by Gaidukov to be actual colloid particles, exhibiting the usual Brownian movement when suspended in fluid. The death of the cell results in complete cessation of the movement—the plasma has coagulated. The liquid watery colloidal solution of the living cell is, in the language of the colloid chemist, a hydrosol, and the coagulated mass a hydrogel. The death of the cell is thus a conversion of hydrosol into hydrogel.

The colloid hypothesis has been further elaborated, but this is not the place to enter into a general discussion of its fuller bearings. It may, however, prove to be a firm stepping-stone leading to a true basis of many of the phenomena connected with the living processes of the cell and with the "life" of the "life-substance" protoplasm.

The account which has been given is necessarily very superficial and sketchy, but it may in some degree indicate that the method is really a useful one, and one of which a good deal may be expected. The glamour surrounding new methods often results in a gross over-estimate of their application; but this glamour, let us hope, has partially disappeared in this particular case, although at first it was very

XUM

decided. Even if it only serves to take us a small step forward in the comprehension of the life of the cell, its continued use will be amply justified.

The following short list of references may be useful to any interested in the subject generally :—

Zeiss. Pamphlets on "Ultra-microscopy" and "Dark-ground Illumination." Parts 1 to 8.

Leitz. Pamphlet, "Reflecting Condensers."

H. Thirkill. "Ultra-microscopy." Science Progress in the 20th Century. 1909–10. Vol. IV. Page 55.

N. Gaidukov. "Dunkelfeldbeleuchtung und Ultramikroskopie in der Biologie und in der Medezin." 1910. G. Fischer, Jena.

A full list of references is given here:—

Úlélah. *Biologisches Centralblatt.* 1911.

Price, S. R. "Observations with Dark-ground Illumination on Plant Cells." *Proc. Camb. Phil. Soc.* Vol. XVI. Part VI. Page 481.

Price, S. R. "The Method of Dark-ground Illumination in Botanical Research. *Sci. Prog.*, Oct., 1913.

Cotton et Mouton. "Les Ultramicroscopes, les Objets Ultramicroscopiques." Masson et Cie, Paris. (Out of print).

Barnard, T. E. "Ultramicroscopic Vision." *Nature.* Vol. LXXIX. 1909. Page 489,

A SOLAR OBSERVATORY IN NEW ZEALAND.

By MARY PROCTOR.

ON April 14th, 1912, I left New York for a lecture-tour in Australasia, for the purpose of arousing enthusiasm and raising the necessary funds for the establishment of a solar physics observatory in that part of the world. Exactly a year later, on April 14th, 1913, I met Mr. Thomas Cawthron, a millionaire, of Nelson, New Zealand, who had read about my lectures in which I had pointed out the necessity for such an observatory in the Dominion, and he generously offered to provide sixty thousand dollars to build, equip, and endow an observatory to be erected somewhere in the vicinity of "the sunny city of Nelson." If Nelson lives up to its reputation in this respect, the institution could not be more favourably situated.

The observatory should prove very valuable for supplying data which will be of great use in connection with meteorology, weather forecasting, and other scientific and practical purposes, such as enabling us to trace the possible connection between sun-spots and magnetic storms on the sun and magnetic storms on the earth.

To establish this theory it was necessary that the sun should be observed continuously throughout the twenty-four hours, but unfortunately a gap of one hundred and fifty degrees separated the solar observatory at Mount Wilson, in Southern California, and the one at Kodaikanal, in Southern India. The proposed observatory at Nelson will not only fill in this gap, completing the chain of such observatories round the world, but it will be the only station of this kind south of the Equator. It will also have the additional advantage of providing a good observing station during the months while winter prevails in the northern hemisphere.

Regarding the climatic conditions of Nelson, they compare most favourably with those of Southern California. The annual average of direct sunshine is two thousand five hundred hours, and of rainfall in inches during the past thirty years is 37·88. Praise of Nelson's climate comes from Professor Archibald, the well-known expert meteorologist, as follows:—"I passed through Nelson twenty-two years ago, and I was impressed by the bright character of the sky." The universal opinion of that time was that Nelson was the climatic paradise of New Zealand. Nelson is a very suitable site for the establishment of a solar observatory and the study of solar physics. Considering that we are now finding that there are oscillations of weather distinctly connected with the small as well as the larger periods of solar phenomena, including the magnetism of the sun and the surface spots, there is little doubt that the projected observatory at Nelson will materially aid meteorologists and physicists to solve the remaining problems which confront us. We shall learn how our luminary affects the weather and other conditions of the earth. It will be work, not only valuable to Nelson and New Zealand, but to the wide world. It will be distinctly to the honour of New Zealand to take a prominent part in an investigation which is daily becoming more and more of world-wide interest and importance. Work such as will be done at Nelson will link with similar study by Sir Norman Lockyer at Cambridge, Professor G. E. Hale at Mount Wilson, and Mr. John Evershed at Kodaikanal in Southern India.

The illustrations show the probable site, usually referred to as the Fringe, situated two thousand five hundred feet above sea level; but at the present moment of writing (May 8th) the matter is awaiting the decision of an expert on such matters from England, at the suggestion of Sir Robert S. Ball, of Cambridge University. About eighteen months ago he was invited to come to Australasia to lecture for the purpose of raising funds for the erection of a solar physics observatory, but owing to his advanced age and duties as a professor at the University he was unable to accept. He suggested that I should come in his place, and the generosity of Mr. Thomas Cawthron has enabled me to state that my mission has been accomplished successfully.

[Since the above was written Miss Proctor has received a letter concerning the serious illness of Sir Robert Ball. Consequently the matter now awaits the decision of Professor Newall, to whom the letter was handed.]

From a photograph *by Tyree, Nelson.*

FIGURE 390.

Mr. Thomas Cawthron, who has offered to establish a Solar Observatory near Nelson, New Zealand.

XUM

FIGURE 391. One half of a panoramic view of the mountains to the South-East of Nelson, New Zealand. Maungatapu Mountain on the left is 3312 feet high.

FIGURE 392. A continuation of the picture seen above. Fringe Hill in the centre is 2580 feet high. On the summit of one of these mountains the Cawthron Solar Observatory will be placed.

From photographs by Tyree, Nelson.

THE CHEMISTRY OF THE FOREST.

By P. Q. KEEGAN, LL.D.

By the chemistry of trees is meant the detection by analysis of such separable and distinctive organic and inorganic bodies as are incidental to the vital processes thereof, whether these substances are the direct outcome of the arboreal life energy, or are merely the by- or waste-products of the spent and exhausted activities. The tree, indeed, may be regarded as the outward and visible sign of an inward and wholly invisible force. The capital force is the one called "vital," shrouded in mystery; but chemical forces, aided in some cases by physical forces, are created and set a-going thereby, and are manifested in visible and tangible shape by the inevitable consequences of a production of principles mostly not detectable in the animal or mineral kingdom. It must be admitted, indeed, that several of the most distinctive constituents of the body of the tree, its stem, leaf, and flower, are not the results of any chemical processes known to science, and cannot be artificially reproduced by the most skilful application of the most modern and approved synthetic methods and expedients; that is to say, the chemical origin of what are called the products of vegetable assimilation is a mystery shrouded beneath the inscrutable veil of forest secrecy. With regard to the woodland soil, it may be briefly stated that it contains much humus, *i.e.*, it is highly charged with organic matter, which is the essential condition of the life of certain fungi which assimilate the nitrogen and carbon thereof, and by association with the roots of the tree (mycorhiza), contribute to supply thereto these necessary aliments in the form of ammonia and carbon compounds.

The arborescent forms of the forest flora of the British Islands are not very numerous, but (native and denizen species included) they are sufficiently varied as respects chemical interest and instructiveness. For instance, in the first place, let us study the chemical characteristics of the Gymnosperms, taking as an example that stately and sombre-foliaged occupant of sandy wastes and craggy mounds known as the Scots Pine (*Pinus sylvestris*). Perhaps heretofore we have regarded the leaf as the most vigorously active of the vegetable organs, but here we see that much of the total energy is assigned to the woody tissues. For it is there that the resin, so characteristic of the Coniferae, prevails. Some specially active parent-cells of the heart-wood contain an opaque plasma which divides again and again, and thus forms a group of several daughter-cells, which separate internally (schizogenous), and so leave a hollow space (resin-passage), wherein there flows the product of their spent and exhausted activity (deassimilation), *viz.*, volatile oil and resin. Then, again, the starch and fatty constituents of the wood undergo curious transformations, or rather alternations. During the winter there is no starch whatever in the wood, pith, or bark, the wood at this time bearing much fat-oil which vanishes in April, leaving only a faint residue thereof during the entire summer. Likewise the leaves (really twigs) are free from starch in winter, but about April 1st, whatever the weather may be, and although the chlorophyll therein is oily and inactive, these organs are found crammed with starch, *i.e.*, in circumstances and conditions that in most dicotyledons would assuredly preclude this effect; and the quantity of this starch gradually diminishes, and disappears altogether in mid-October. Coniferous leaves in their most developed condition are always poorer in nitrogenous, carbohydrate, and mineral (ash) constituents than those of deciduous trees, and the ash is also of a somewhat different composition. Hence we learn that our arborescent Gymnosperms (pines and firs) are subject to a fitful periodicity of life-energy interrupted by pretty long periods of repose akin to hibernation, all preordained and operative in the first place in the formed leaves, ere the buds are evolved or the cambium has awakened. A speciality, too, is the strong accumulation of "dry substance" in the tissues under the form of resins, waxes, volatile oils, tannins, tannoids, glucosides, phlobaphenes, and lignin (but not acids), while, on the other hand, the relative amount of starch, fat-oil, carotin, chlorophyll, and albuminoids is comparatively small.

Reviewing now the more familiar field of the Dicotyledons, and in the first place the various species of Elm (*Ulmus campestris*, and so on), we are arrested at once by the presence of a very troublesome constituent known as vegetable mucilage. In the cortex, special sacs or canals evolved from the meristem, and in the leaves cellulose-encased roundish compartments in the epidermises, petioles, and nerves contain mucilage in large quantity. It is a degradation product of cellulose provoked by the great undue pressure of growth: it swells enormously in water, and has an acidic function. Some resin occurs in elm bark and wood parenchyma, but the quantity of tannin is decidedly scanty in all parts of the tree. The leaves contain much carotin, wax, albuminoids, and sugars at all times, and their starch-producing power is extremely vigorous. In fact, the tree is a very distinctive starch-tree, and it retains most of it in winter, little or no oil appearing then in the tissues. The average amount of transpiration is only moderate, its flowers, fruits, and leaves grow rapidly, but are short-lived, as the lavish fortification of its bark, leaves, and even fruits, with lime and silica, attests, and some of its varieties are even capable of forming a primary persistent periderm, albeit only feebly suberified.

Passing on now to those nearly allied, closely related (taxonomically) congeners, the Birch and the Alder, we begin to realise the supreme value of chemical analysis as applied in the world of plants. Both are fat-trees, for in winter the starch vanishes from the pith, wood, and bark, because the leaves produce little starch, and the general reserve thereof is feeble and readily exhausted. So far they agree, but in the Birch the process of deassimilation is not so complete as that in the Alder. In the Birch it is not pushed much beyond the production of waxes, resins, and volatile oils, and hence the tannins, phlobaphenes, pigments, and so on, are comparatively sparse. Hence in the "queen of the woods" we observe a silvery-whitish bark, of ghastly aspect by moonlight, containing some twelve per cent. of a white hydrocarbon (betulin), easily resinifying in the air, but only about five per cent. or less of tannin, and very little hidden phlobaphene. The phellogen that works this effect is stimulated to action by the rapid growth of the very sappy internal tissues. On the other hand, in Alder bark there is found sometimes as much as twenty per cent. of a powerfully astringent tannin, together with some emodin, which is a higher product of deassimilation again. This tannin penetrates freely into the medullary rays, parenchyma, and pith of the wood (birch-wood is almost free from tannin); and although it does not conduce much to lignification, it renders the wood very resistant to the action of water. Birch leaves produce more starch, cellulose, fibre, wax, volatile oil, resin, ash, silica, and soluble salts than Alder leaves do; but these, on the contrary, contain much more nitrogenous matters, and more fat-oil, tannin, pigments, acids, lime, and manganese. Thus we come to perceive that more fundamental differences exist between these two tenants of the forest than what a mere recital of the few and slight specific characters (chaff-like or woody, falling or remaining scales of the seed-bearing catkin, and so on) would in any way foreshadow or prognosticate.

Certain members of the order Cupuliferae must now claim our attention. As regards the grand old Oak, it may be asserted that no member of the vegetable kingdom has been more exhaustively investigated. All that we need state here, however, is that the amount of starch which it creates and

XUM

stores up in all its organs is considerably larger and more durable than that of any tree in our sylva. The beautiful Beech exhibits a distinctive variation in this respect, inasmuch as even in January and February its wood is very rich both in oil and starch, every cell in the parenchyma of the outer rings being full of starch (not the case in most starch-trees), and this remains up till April, when the wood is still rich in oil (in fat-trees there is little oil in spring or summer). In the Beech, too, the wood becomes lignified very slowly; the quantity of tannin produced here and elsewhere is relatively small; it lays up a store of starch in the inner rings in a rare manner, and it requires more nitrogen, potash, and lime than many other trees. "The whole tree" says Wicke, "sticks, so to speak, in a siliceous coat of mail, the silica forming a thick solid crust over the whole stem and the young twigs" (the actual white colour of the bark is, however, due to lichens). The pure ash of the bark contains up to ninety per cent. carbonate of lime, indicating an enormous affluence of acids, mainly oxalic. The chief difference between Beech and Oak, as revealed by the chemistry of their leaves, is that the latter is more vivacious than the former: the Oak has much more tannin and carbohydrates, and its protein falls off in greater amount towards autumn, at which time also the quantity of silica in its ash is little over half of what it is in that of the Beech; this latter tree, however, evolves more fat-oil, its ripe nut containing some twenty per cent. thereof, while the acorn produces only about six per cent. at most. This various outcome of these two constituents seems referable to the varying capacity of the two trees to withstand the effects of external conditions of weather, and so on.

We now approach the Ash (*Fraxinus excelsior*) with its smooth bark and knotty protuberances; and it must be confessed that it is difficult to render full justice to its perfection of organisation and to its wonderful wealth of chemical constituents. In fact, we here enter upon a new chapter in the chemistry of the forest. In 1856 Prince Salm-Horstmar discovered in the infusion of the bark a peculiar fluorescence, and in 1857 he isolated and examined the substance causing it and named it *fraxin*. Its dilute aqueous solution with a trace of alkali exhibits by reflected light a strong bluish fluorescence, due to the absorption of certain rays. It is a colourless crystalline glucoside perhaps derived from cinnamene. The tannin of the Ash totally differs from that of any of our native or denizen trees, the Holly excepted. In fact, it is identical with the tannin of coffee, and is accompanied by a tannoid whose dun shades with alkalies produce the blackish Ash leaves in the fall. Ash leaves, indeed, may be ranged among the wonders of British botanical chemistry. They rival the Oak in the manufacture and storage of starch, but far surpass it as respects carbohydrates, such as mannite, inosite, and also malic acid, malates, and mineral matters, but have not so much wax, fat, carotin, tannin, or mucilage. The difference in this case arises from the nature of the protoplasm, or of its behaviour. While, on the one hand, the products of assimilation are only somewhat different, on the other hand the products of deassimilation exhibit a marked variation. Thus, while the tannin of all the trees hitherto considered contains what is called a phloroglucin nucleus, that of the Ash has a quinol nucleus, and, moreover, it is linked on to the derivatives of a hydrocarbon which indicate that a larger number of carbon and hydrogen atoms are relinquished on the disruption of the albuminoid molecule. This means that the process of oxidation in this particular direction is carried in the Ash leaf to a loftier pitch than is the case with regard to the preceding organisms in our review. The Ash is a tree of great soil consumption, and its leaves retain their vitality up to the first frosts, the ash therein amounting to 10·5 per cent. in dry matter with 45·8 per cent. of lime. Curious how it is that this tree sucks up no manganese from the soil, while closely contiguous plants and trees may absorb a great deal.

The lordly Sycamore and some of its allies remain to be considered. The chemistry here is comparatively simple. They are all starch trees, but at the same time are rather oily. Thus there is a lavish plaster of wax on the lower epidermis of the leaves of a Sycamore. Its bark is very poor in tannin, and has no resin apparently, but a saponin-like substance, very much oxalate of calcium, and 9·4 per cent. of ash are found here. Its vital powers awaken early in the year, for concurrently with the regeneration of the starch in spring a quantity of cane-sugar (rising mainly from the roots or base of the trunk) becomes dissolved in the cell sap, which thereby gains sufficient tension to bleed out through the bark if pierced. The adult leaves have no reserve of starch, having no true chromoplasts, but contain much carotin, wax, and albuminoids at all times, also a good deal of tannoid and tannin, only a little sugar or mucilage, but much oxalate of calcium almost from birth, and 11·2 per cent. of ash, which even on 8th August yields 14·9 per cent. silica. The fact that in the leaves the production of starch declines towards the autumn, while the cellulose does not increase, the albuminoids and sugars remain uniform till very late, and there is a heavy fixation of silica and lime in the old tissues, indicate the rapid growth and early decline of vitality of these organs. That well-known ally, the Horse Chestnut, exhibits a similar chemistry, except that its fruit contains starch and saponin, and its bark yields the brilliantly fluorescing aesculin discovered by Canzoneri in 1825. The tannin of these Aceraceae is especially competent to evolve very brilliant crimson tints, as is seen in the American Maples in Autumn, but our species, alas! are precluded from this beauteous display by reason of the sharp weather fangs that cause a premature demise of their external tissues.

By way of summary it may be concluded that starch trees are Elm, Oak, Ash, Sycamore; fat-trees are Birch, Alder, Linden, Scots Pine, Holly. The richest in starch, but having less chlorophyll, are Birch, Ash, Elm, Scots Pine, Oak; poorer in starch, but having more chlorophyll, are Beech, Sycamore, Alder, Poplar, Rowan. As to nitrogen the leaves of Alder, Elm, Beech, Willow, Linden, Sycamore, contain most; while those of Oak, Hazel, Poplar, Ash, have less, as against those of Birch and Scots Pine, which contain the least. Trees rich in waxy and fatty matters are Scots Pine, Sycamore, Beech, Alder, Birch; while Oak, Ash, Elm, Poplar, Holly, produce one half or less thereof. The greatest proportion of lignin or crude fibre is found in Scots Pine, Oak, Sycamore, and rather less in Ash, Elm, Birch, Alder, and Hazel. Alder and Oak produce the most tannin; there is much less in Beech, Elm, and Poplar. The mineral matters of the soil are most strongly absorbed by Elm, Sycamore, and Ash, while the other trees flourish with vigour in most cases on a much sparer diet of that sort.

SAGACITY OF A DOG.

MR. JAMES SAUNDERS, of Luton, contributes the following to *The Selborne Magazine*:—

"There were two terrier dogs, a black smooth-coated one, and a rather larger white one. The latter was in the water by his own desire, where he was enjoying himself. The black one slipped off the stone coping and had an involuntary bath. He tried to extricate himself by striving with his fore-paws to gain the top of the coping, but the sides of the lake were so perpendicular that his hind feet could get no grip. He partially succeeded several times, but always fell back till he showed evident signs of distress. In the meantime the white dog had left the water by the shallow river bed, and at once went to see what the other dog was doing. He soon realised the gravity of the situation and tried to grab the black dog by the neck. In this he failed several times, but at last got some of his teeth under the other dog's collar and hauled him out instantly."

XUM

COSMOLOGICAL HYPOTHESES.*

By R. T. A. INNES.

THE best known and still the most widely accepted cosmological theory is Laplace's nebular hypothesis. This hypothesis was only put forward in a tentative manner by its author, although on several occasions he recurred to the subject. It is proper to note that although it is doubtful if anyone had ever a greater facility for clothing his ideas in mathematical formulas, Laplace used none in explaining the nebular hypothesis. Many cosmogonies have been based on ideas not essentially different from Laplace's—that is, the condensation of a primitive nebula into rings, which later disrupt into planets, whilst the central and final condensation forms the central body or sun of the system. The fission theory of the formation of satellites and double stars from condensing bodies is closely connected with the nebular hypothesis.

Other sets of cosmogonies are indicated under the meteoric or planetesimal hypothesis, and capture theory. Kant's cosmogony was more general in that he postulated neither nebulous matter nor meteors—merely matter. The nebular hypothesis of Laplace, and its modifications by Faye, du Ligondes, Darwin, See, and others, seized on the popular mind because it was not in too marked discord with the theological teachings of the age, "the earth was without form, and void." Genesis i, 2.

By the very mode of its existence the human race can view but a small part of the drama of nature. On the surface of the earth, thanks mainly to the geological record, the mode of the evolution of flora and fauna and the making of rocks is fairly clear. But when we view not the surface of the earth, but bodies outside the earth, the planets, stars and nebulae, our interpretation is not so easy. We cannot even say if the sun, and with it the earth, is growing hotter or colder. We imagine the rhythm of the universe is periodic, but until one period is completed — and this the human race cannot live to see—how can we tell, nay, even guess, the nature of its periodicity! The periodicity may be complicated, is almost certainly more complicated than that of a butterfly which goes through the stages, egg, caterpillar, chrysalis, butterfly, and so on, and what being could by the closest inspection of, say, a millionth of any one of the sub-periods, egg, caterpillar, chrysalis, or butterfly, foretell the other sub-periods! It is probably thus when we attempt to explain the evolution of the stars. When Laplace wrote his nebular hypothesis facts were few, the laws of thermodynamics had not even been formulated, and modern chemistry was in its infancy. Hypotheses without facts are not uncommon; the Greek geniuses loved hypotheses, but seemed to disdain facts, and the effects of their examples are buried deep in the fibres of our mentality. The fundamental assumption of the nebular hypothesis is that a nebula can condense, not only get more dense, but even ultimately form liquids and solids of various atomic weights. This assumption has no foundation in nature, and is so improbable that it should not be accepted without proof. Lockyer's meteoric hypothesis started with a swarm of solid bodies, meteorites, which by their collisions gave rise to a nebula, which then followed the Laplacian theory; but the spectroscopic evidence on which it rested has since been proved to be devoid of foundation.

Although many cosmological hypotheses have been imagined, I wish to show that another can be added to them; its only merit is that it takes into account the few facts of observation which are available to-day. The hypothesis is compounded of the planetesimal hypothesis of Chamberlin and Moulton, and the radiation theory of Arrhenius, with the addition of an explosive element suggested by the mutations of uranium radium-helium.

The primordial stuff out of which the universe is made is in the form of meteors. Aggregations of meteors are caused by collisions and gravitation. These aggregations increase in size forming, firstly, cometary bodies; secondly, planetary bodies; thirdly, sun-type bodies. Growth is continuous in one direction in all these bodies, so that a cometary body by the addition of more meteorites can pass into a planetary body, and a planetary body similarly into a sun-type body, but a sun-type body cannot increase in size indefinitely, as a time comes when it will disrupt with explosive force. A cometary body is a loose aggregation of meteors. A planetary body is a solid body in which the forces of solidification and cohesion are at a maximum. A sun-type body is a liquid body, of which the sun is a prototype. The reverse process cannot take place; thus a sun-type body cannot shed meteorites and so lose matter that it becomes a planetary body, and so on. Under certain circumstances, such as the near presence of a large mass, a cometary aggregation can, however, be dissipated, but this is an indirect effect which does not concern us here. All three classes of bodies can radiate substance in the form of electrons, although at vastly different rates, so that they can pass from the solid or liquid state to the gaseous state, which is and will be called here the stellar state, and from the gaseous or stellar state to the final form, the nebulous state. The stellar state is the first step in the degradation of atomic matter.

It has to be considered how this hypothesis fits

* A paper read to the Science Congress, Lourenco Marques.

XUM

facts. Clausius has taught us that the end of the universe as an abode of life or available energy will be reached when entropy becomes a maximum, and that it does tend to such a maximum. This conclusion is not contradicted, it is only enlarged so as to include in the available energy the enormous stores of power contained in every atom. The end of the universe, or at least one sub-period of it, is reached when every atom has disintegrated into its component parts, be they electrons or the elusive nebulium of which nebulae are mainly composed. The older cosmogonists started with nebulium, which in some way could condense into atoms and end with vast cold stars consisting of heterogeneous collections of atoms containing enormous stores of unavailable energy. The present hypothesis reverses the process. We know there are meteorites—numbers flash through our atmosphere and are seen on every clear dark night; a few reach the surface of the earth. Examination and analysis of the meteors which have been found show that in the main these bodies contain all the elements found upon the earth, and that they are compact bodies formed under considerable pressure. How they came into being is quite unknown; to us they must represent an earlier stage or sub-period of the universe akin to the egg or chrysalis stage in the butterfly's period of existence. The earth is increasing its mass by these falls of meteorites, but the increase although constantly in action is very slow. But it is improbable that the planets of the solar system were formed by this process; it is possible that the planets grow by accretion, but their formation was due to explosions of the central mass. As long as matter was considered to be inert, there was no limit to the quantity of it which could be assembled in one mass and held together by the power of the mutual gravitation of its parts. But it is obvious on further thought that a time will come when the gravitational pressure of a mass will break into the atomic structure of its matter and cause explosions. It is by such explosions that planets are thrown off. We can imagine that in the solar system one great explosion threw off all the planets and their satellites, and that some of the satellites are due to sub-explosions at the same epoch, and some due to capture of remnants. In this, the solar-type of explosion, but one seven hundred and thirtieth part of the solar mass was thrown off, but we may expect all types of explosions—thus the original mass might explode into two nearly equal parts, examples of which we see in many double-star systems, or the explosion might be so shattering that the original mass is almost uniformly broken into thousands of fragments forming a star-cluster like ω Centauri or ξ Toucani. Or the mass of a system may so nearly balance the explosive force that explosions are muffled and intermittent; these would give rise to stellar-variability or, in the case of a body like the Sun, act as one of the causes of sunspots. It has been shown that some of the transformations of radium are rhythmic, a fact which suggests that the sunspot period may be due to atomic disintegration.

Here we may remark that it is not impossible that explosive action on the Earth, as shown in volcanic action, is due to the liberation of atomic energy; formerly it was ascribed to the percolation of water into hot strata, but the recent researches of A. Brun have proved that the ejecta of volcanoes are free from either steam or water. A time comes when the central mass of a system becomes fairly quiescent, such as the Sun now is. In this quiescent stage the Sun is a globe of liquid with an enormous radiation of heat and light waves, and emitting electrons; its heat is mainly due to atomic disintegration which will continue as long as any of it remains, or, in other words, as long as it contains atoms of more than gaseous atomic weight. Its end will be approached by its passing into a gaseous or stellar state, which will later devolve into a nebula. There are no dark suns or stars. Continuity requires that the Earth and other planets should be going through a like process, but on a much slower scale owing to their smaller masses, and perhaps, also, to the different proportions of the elements of which their chemical constitutions are built up; one can imagine that whilst, say, Jupiter is still growing by planetesimal accretion, the Sun's attractive mass may become so small through the emission of electrons that the centre of our system will be transferred, in the course of ages, to the planet Jupiter.

The explosion hypothesis suggests an explanation for the phenomena exhibited by the so-called Novae or new stars; these are small stars which almost instantly increase enormously in luminosity and slowly and somewhat irregularly fade away, often to small nebulae. These may be assumed to be gaseous stars, in which the ratio of their specific heats exceeds one and one-third; they are then essentially unstable, and a time comes when a radical change of state occurs—a sudden blaze up, followed in most cases by a rapid disintegration into the final state of nebulosity, in which entropy has become a maximum and atomic energy a minimum.

The implication of this hypothesis in the glacial epochs of the Earth is simple. A glacial period will come on slowly as the heat of the Sun falls through the rhythmic close of a period of chemical disintegration; the hot period will come on suddenly with a prodigious melting of the waters, a time of maximum temperature following the epoch of greatest cold comparatively closely. If temperature and time were plotted the curve would resemble that of the light of a variable star, as it should, because the cause at work is the same.

If we seem to live in an age of uniformity in temperature conditions, it is perhaps because the race can only flourish under such circumstances; the theory gives no promise of continued uniformity. An explosive disintegration of atomic energy on the Sun may occur at any time. We can only surmise from past conditions on the Earth that at present the Sun is getting colder in preparation or as an

antecedent to a further outburst. Here again the behaviour of variable stars is an indication; although some of these stars are remarkably regular in their changes, others are not, and generally the fainter the minimum the more rapid and brighter the following maximum.

In building up the above hypothesis the following facts of observation have been borne in mind:—

1. The mutation of heavy elements, such as uranium (atomic weight 238·5) into helium (atomic weight 4) with an enormous liberation of energy spread over thousands of millions of years.
2. The changing of stars into nebulae of which some four or five cases are known, whereas the reverse process is unknown.
3. Gaseous stars (spectra showing helium and hydrogen, with or without bright lines) are very light, their density not exceeding one-ninth that of the Sun, whilst their gravitative power seems to be "nil." Thus the brilliant close pair α Crucis shows no orbital motion, whilst the essentially wider solar-type star α Centauri is a rapid binary pair. (N.B. —Wider is used in a mathematical sense and includes the effect of surface luminosity; so far as distance alone goes, α Centauri is not so wide as α Crucis.)
4. Nebulous matter is found near most stars of the gaseous types—thus the nebulous regions of Orion are in the midst of helium-type stars; nebulous matter is unknown near solar-type stars.

As, under the explosion hypothesis, the Sun is liquid it cannot maintain its temperature by contraction, because liquids are virtually incompressible, hence Helmholz's theory of the maintenance of solar heat is not applicable. It is further improbable that gaseous or stellar-type masses always contract as they radiate heat; on the contrary, Kelvin's investigations indicate very strongly that such masses of gas may expand. The argument that spiral nebulae are systems in formation, overlooks the palpable fact that these objects are exceedingly faint. Long exposure photographs give very misleading pictures of spiral nebulae. In nearly every case the total brightness is less than any one of its neighbouring small stars. It would be of the same order of reasoning to assert that islands are formed out of wisps of cirrus cloud.

The commonly received view that gaseous stars are hotter than liquid or sun-type stars has perhaps been engendered by the classification really based on the nebular hypothesis, *viz.*, that white stars are the hottest and that sun-type stars already show signs of cooling, but Huggins clearly shows that solar-type stars are the hotter—thus in his "Atlas of Spectra," 1899, page 85, he says:—

"In strong contrast with this falling off in Vega at about λ 3,700 the continuous spectrum of the solar stars, Procyon and notably Capella—that is to say, the narrow bright intervals between the numerous strong dark lines, . . . is obviously far more intense." And it may fairly be asked, if the gaseous or stellar type of star is the hotter, why it should not show metallic lines in its spectrum. The answer, under the new hypothesis, is that such stars no longer contain substances of high atomic weight, as these substances have disintegrated into the simpler gaseous elements.

One cannot imagine the process, in a universe tending to uniformity and to a maximum of entropy, by which a simple gas, such as nebulium is, can be transformed into complex atoms containing enormous stores of energy. The reverse process seems to be a more fitting one; it starts with heterogeneity and finishes with homogeneity. In short, Laplace's nebular hypothesis as a representation of nature is quite untenable, as it is contrary to observation and to known chemical and thermodynamical laws; in spite of this, literally volumes of mathematical deductions (but not by its author) have been drawn from it.

I have added a list of references to various modern authorities whose views have influenced my own; some numerical results have been quoted.

REFERENCES.

Barnard.—"The Temporary Stars. On the present appearance of some of these bodies." *Astronomische Nachrichten* No. 4655, 1913, May 20th.

Nova Cygni, 1876: Its appearance is distinctly hazy.

Nova Aurigae, 1891: Its image is ill-defined.

Nova Sagittarii, 1898: It is always hazy and ill-defined.

Nova Lacertae, 1910: It presented the appearance of a very small nebula, less than 2-in. in diameter, of a bluish-white colour.

Chamberlin, Moulton and others. "Contributions to Cosmogony and the Fundamental Problems of Geodesy." "The Tidal and Other Problems," 1909.

This is a remarkable work, which is published under cost price by the Carnegie Institution of Washington, but it is so poorly advertised that its circulation is far below its real merits. For this reason, I venture to quote some of the conclusions reached in it.

Chamberlin:—"The application of the most radical and the most rigorous method of estimating the frictional value of the present water-tides . . . seems to show that they have only a negligible influence on the Earth's rotation . . . The tides of the lithosphere are chiefly elastic strains, and have little retardative value . . . The accelerative forces seem to be also negligible . . . There has been no such change in the rate of the Earth's rotation . . . as to require to be seriously considered in the study of the Earth's deformations." (Page 59).

Chamberlin writes (page 23):—"There can be no

theoretical doubt that there are tides of the lithosphere."

Since then Professor A. Young's discovery of lunar-tide effects on the Karoo has since been published. ("Tidal Phenomena at Inland Boreholes near Cradock," *Trans. Roy. Soc. of South Africa*, 1913, Vol. III, Part I.)

Moulton:—"In a word, the quantitative results obtained in this paper are on the whole strongly adverse to the theory that the Earth and Moon have developed by fission from an original mass, and that tidal friction has been an important factor in their evolution. Indeed, they are so uniformly contradictory to its implications as to bring it into serious question, if not to compel us to cease to consider it as even a possibility." (Page 133.)

" . . . The hypothesis of Laplace has the support of no observational evidence. On the contrary, there are well-known considerations . . . which compel us to reject it . . ." (page 137). As to the possibility of the fission-theory of the formation of satellites, planets and double-stars, Moulton's conclusions are:—

"(1) We find that the Sun cannot arrive at this critical stage (fission) until its mean density shall have exceeded 307×10^{11} on the water standard. This corresponds to an equatorial diameter of the Sun of about twenty-two miles.

(2) We find that the Sun cannot become so oblate as Saturn is now until its mean density shall have exceeded 148×10^{10} on the water standard. . . . Since even the latter density is impossibly great we conclude that the Sun will never become so oblate as Saturn is now, and that it will always be more stable than Saturn is now.

"(3) We find that Saturn cannot arrive at the critical state at which Jacobian ellipsoids branch until its mean density shall have become twenty-one times that of water. . . We conclude because of the great density demanded that Saturn will never suffer fission." (Page 159.) "Perhaps the hypothesis that stars are simply condensed nebulae, which has been stimulated by a century of belief in the Laplacian theory, should now be accepted with greater reserve than formerly. Up to the present we have made it the basis not only for work in dynamical cosmogony, but also in classifying the stars. It may be the time is ripe for a serious attempt to see if the opposite hypothesis of the disintegration of matter—because of the enormous sub-atomic energies, which perhaps are released in the extremes of temperature and pressure existing in the interior of suns, and of its dispersion in space along coronal streamers or otherwise—cannot be made to satisfy equally well-known phenomena. The existence of such a definitely formulated hypothesis would have a very salutary effect in the interpretation of the results of astronomical observations. We should then more readily reach what is probably a more nearly correct conclusion, *viz.*, that both aggregation and dispersion of matter under certain conditions are important modes of evolution, and that possibly together they lead in some way to approximate cycles of an extent in time and space so far not contemplated." (Page 160.)

Lunn.—"Geophysical Theory Under the Planetesimal Hypothesis."

In this paper, if I grasp aright the meaning, the author shows, by adopting plausible laws of compression and density, that it is only small bodies that can be very dense, which is borne out so far as they go by astronomical observations; thus we have

Type.	Body.	Mass.	Density.
Planetary ...	Meteorite ...	Infinitesimal	3 to 8
" ...	Mercury ...	1/5000000	1·21
" ...	Earth ...	1/330000	1·00
Sun or Solar...	Sun ...	1	0·26
Stellar or Gaseous...	Algol* ...	3	0·14
" "	β Lyrae ...	9·6	0·00016

* Uncertain, Stebbins gives Mass 0·55, Density 0·02.

Cox.—"Beyond the Atom," 1913.

"One pound of the emanation would, at its maximum intensity, radiate energy at the rate of about ten thousand horse-power. This large emission of energy from the radio-active bodies throws an interesting light on two questions which have long been the subject of controversy, the age of the Earth and the source of the heat of the Sun." (Page 109.)

Period of fall of Uranium to half-value six thousand million years. (Table, p. 91.)

Kelvin (and Green).—"The Problem of a Spherical Gaseous Nebula." *Trans. R. S. of Edin.*, 1907-8.

"It is scarcely possible to conceive that any fluid composed of the chemical elements known to us, could be gaseous in the Sun's atmosphere at depths exceeding one hundred kilometres." (Page 268.)

Kelvin calls a gas in which a the ratio of the specific heats is greater than $1\frac{1}{3}$ a gas of species P; and it is almost certain that all monatomic gases have $a = 1\frac{2}{3}$.

"We see that the central temperature of a globe of gas P in equilibrium increases through gradual loss of heat by radiation into space. We then see also that the internal energy of a globe of gas P, continuing in a condition of approximate equilibrium while heat is being radiated away across its boundary, would go on increasing, and the work done by mutual gravitation of its parts would go on increasing till the gas in the central regions becomes too dense to obey Boyle's Law." (Page 281.)

In this statement no account is taken of any possible liberation of atomic energy, but, even without this, it is evident that the underlying idea of contraction is at fault, and that a decrease of internal temperature and increase of size could go on together. So far as observation goes, the evidence is in favour of the latter view. Although hardly supplying an exact parallel, it is well known that the gaseous envelopes of comets contract as they approach the Sun.

Newcomb.—"The Stars: A Study of the Universe." 1902.

"A very remarkable case is that of Zeta Orionis. It has a minute companion at a distance of 2″·5. Were it a model of the Sun, a companion at this apparent distance should perform its revolution in fourteen years, But, as a matter of fact, the motion is so slow that even now, after fifty years of observation, it cannot be determined with any precision. It is probably less than 0″·1 in a year. The number expressing the comparison of the density and surface brilliancy of this star with those of the Sun is probably less than 0·0001. The general conclusion to be drawn is obvious. The stars in general are not models of our Sun." (Page 200.)

Newcomb.—"Popular Astronomy," 1882.

"Then a mathematical computation of the attractive power exerted by such a system of masses (five hundred million sun-masses) shows that a body falling from an infinite distance to the centre of the system would acquire a velocity of twenty-five miles a second." (Page 501.)

This calculation does not seem to be correct, but it serves to show how impossible it is for the potential energy of a nebula composed of nebulium, helium and hydrogen to be changed by gravitation into the radio-active and other atomic energies of heavy atoms. The velocity with which a small mass falling from rest at an infinite distance would strike the Sun is three hundred and eighty miles a second. This means that a gram falling into the Sun would generate forty-four thousand eight hundred and forty-four calories; this is but one five hundred thousandth of that evolved by radium.

Perry.—"The Life of a Star." *Nature*, 1899, July 13th.

"Assumptions like those of Homar Lane and Ritter may lead to results which are altogether wrong. . . . Homar Lane, Lord Kelvin, Ritter, and all people who have tried to make exact calculations, have assumed that the stuff of which a star is composed behaves as a perfect gas in a state of convective equilibrum. . . . But if we apply our results to the Sun we find that at its centre there is a density thirty-three, that is, fifty per cent. greater than the ordinary density of platinum. It seems to me that speculation on this basis of perfectly gaseous stuff ought to cease when the density of the gas at the centre of the star approaches 0.1 or one-tenth of the density of ordinary water in the laboratory. . . It seems to me that if a mass of this kind of gas (in which γ the ratio of its specific heats$=1\frac{1}{3}$) gravitates by itself from an infinite distance, it retains all its energy. But such gas must surely be imagined to be radiating heat, as it is not at zero temperature. Where can it get such heat? I come to the conclusion that there must be atomic energy available somehow in it. . . I say that no substance for which $\gamma = 1\frac{1}{3}$ can behave as a perfect gas."

Kelvin's remarks on and his endorsement of Professor Perry's conclusions will be found in *Nature*, 1907, February 14th.

Ramsay. "Elements and Electrons, 1912."

"Cordite, the explosive powder used for our artillery, evolves 1,253 calories per gram. . . Radium, 2,800,000,000 calories."

CORRESPONDENCE.

"THE ORIGIN OF LIFE."

To the Editors of "KNOWLEDGE."

SIRS,—I have seen Mr. H. Stanley Redgrove's article in the August number of "KNOWLEDGE" in which he refers to a "nine days' wonder" produced by my experiments on the action of radium salts on sterilised organic media, such as gelatin bouillon used for the cultivation of bacteria. He adds that Mr. Soddy showed the effects were of a purely chemical nature. I was not aware that Mr. Soddy had made any experiments upon the subject; nor do I believe that unlike the effects produced by barium, strontium, and lead salts, the results due to radium are of a purely chemical nature.

The effects are on the whole physical rather than chemical as I have repeatedly pointed out, and as Sir William Ramsay was good enough to explain they might have been expected to be. My own views upon the subject were put forward at length in my article in the *Fortnightly Review*, September, 1905, and in my book on the "Origin of Life" published in 1906, of both of which Mr. Redgrove is apparently unaware. If these experiments remain a nine years' wonder I throe not, but I venture to deny, considering the prolonged discussion to which they have given rise, and are likely yet to give rise to when more fully understood, that they were a nine days' wonder if indeed they can be said to be a wonder at all.

JOHN BUTLER BURKE.

WEYBRIDGE.

BRITISH MEASURES NEARLY HYDROMETRIC.

To the Editors of "KNOWLEDGE."

SIRS,—It is not, perhaps, generally known that our British system of weights and measures is very nearly ***hydrometric***, that is, having a simple relation between the measures of length and weight through the medium of ***water***. If we suppose that the gallon is reduced by the small amount of three one-thousandth parts, we have the following interesting and useful relation:

Sixty-four cubic feet = four hundred gallons.

We may visualise this by picturing a cube which measures four feet in each direction and therefore contains $4\times4\times4$, or sixty-four cubic feet.

Now by law a gallon of water weighs ten pounds; and to preserve this relation we must suppose the pound to be reduced by the same small amount as the gallon. If this be done, and if for convenience we call our four-foot cube a "vol," we shall have

One vol of water weighs two tons (four thousand pounds).

An easy deduction from this is

One cubic foot of water weighs one thousand ounces

and from this again we have

$\frac{1}{10}$-foot cube of water weighs one ounce.

IMMO S. ALLEN.

LONDON INSTITUTION,
FINSBURY CIRCUS, E.C.

THE HISTORICAL MEDICAL MUSEUM.

IN our notices in the August number of "KNOWLEDGE" allusion was made to the Historical Medical Museum, organised by Mr. Henry S. Wellcome, and formally opened by Dr. Norman Moore, the President of the Section of the International Medical Congress which dealt with the history of medicine. The idea of forming a museum illustrating the history of the healing art occurred to Mr. Henry S. Wellcome several years ago, and the remarkable collection of rare and curious objects of historical interest connected with surgery, medicine, and the allied sciences brought together from all parts of the world is now housed at 54a, Wigmore Street, London.

Dr. Norman Moore in the course of his opening address said that the Museum, which had been recognised as a part of the History of Medicine Section of the International Medical Congress, formed a most important addition to its studies. He reviewed the formation of earlier museums, all of which are relatively recent creations and usually developments from libraries. In the reign of Elizabeth, John Dee formed one of the first, a collection of mathematical and astronomical instruments and of various curiosities in his library at Mortlake, but the first considerable museum in England was that of John Tradescant, father and son, at Lambeth. The catalogue of the Tradescantian Museum was printed in 1656, and shows that it had fifteen sections, among which were beasts, birds, reptiles, weapons, and many dried plants and fruits; for the Tradescants were primarily gardeners and collectors of herbs. Their museum went to Elias Ashmole, and was re-arranged at Oxford, where most people have seen the unique head and foot of the dodo, the body having been destroyed in one of those periods of darkness to which all universities are liable.

Another great museum was formed in London by James Petiver, an apothecary to the Charterhouse, who was educated at Rugby School and at St. Bartholomew's Hospital. He was a botanist and entomologist, but the many sea captains whom he came to know, brought him every kind of curiosity from all over the world. Sir Hans Sloane bought his collection and others, made a great one of his own, and bequeathed the whole to the nation.

All these early museums were associated with libraries and contained every kind of specimen, and this form the British Museum still retains. The museum of Francis Calceolari, of Verona, is described in a folio of eight hundred pages printed in 1622, and a picture of the museum showed the original form which developed into such a collection as is the British Museum. The specimens were in a well-proportioned room, paved with variegated marble and surrounded by an ornate sort of dresser with drawers and shelves. At one end were books and on the shelves all round were specimens. On one side was a statue of Atlas bearing the world, showing the regions whence the specimens had come, and on the other Minerva, showing that all learning was included in the collection.

The gift of Dr. William Hunter to the University of Glasgow was another museum of this type. It contains pathological, anatomical, and natural history specimens, manuscripts, pictures, early printed books, Greek and other coins.

A more limited kind of museum succeeded these vast collections, of which a type is the collection of anatomical preparations formed by Edmund King, surgeon to St. Bartholomew's, in the seventeenth century. Of these specialised museums the greatest was that of John Hunter, now under the care of the Royal College of Surgeons in Lincoln's Inn Fields.

The museum, which they were there to open was the first established in England to illustrate the history of medicine, and it might justly be regarded as a further step in the establishment of the subject as a regular study.

The origins of medicine might be studied in two directions. In the hall in which they were assembled could be seen two figures which typify these. There was Ixtilton, the Mexican god of healing, his head covered by a grotesque mask, a necklace of the teeth of the sperm whale round his neck, a curious instrument of enchantment in his right hand, seeming to have uttered some strange and terrifying ejaculation as he extended his left hand. Near him was the Apollo Belvedere, the most perfect of the sculptured representations of men; his face showed the highest flights of thought and powers of observation. The figure of Ixtilton suggested charms, amulets, and magical ceremonies. The figures of Apollo and of his son Asklepios suggested observation, experiment, and reasoning.

. . . . .

It is always useful when considering the development of any phase of human activity which began at a time before written records were made, to study what is done at the present day by uncivilised people, and one section of the Historical Medical Museum is devoted to what one might call superstitious medicine, to the fancies and fetishes of savages and the ways and implements of witch doctors. For instance, in the entrance hall we find one of the rough figures from the outside of a village, into which scores of sufferers have driven spikes and nails, indicating the places in which they felt pain

FIGURE 393. The Barber Surgeon's Shop.

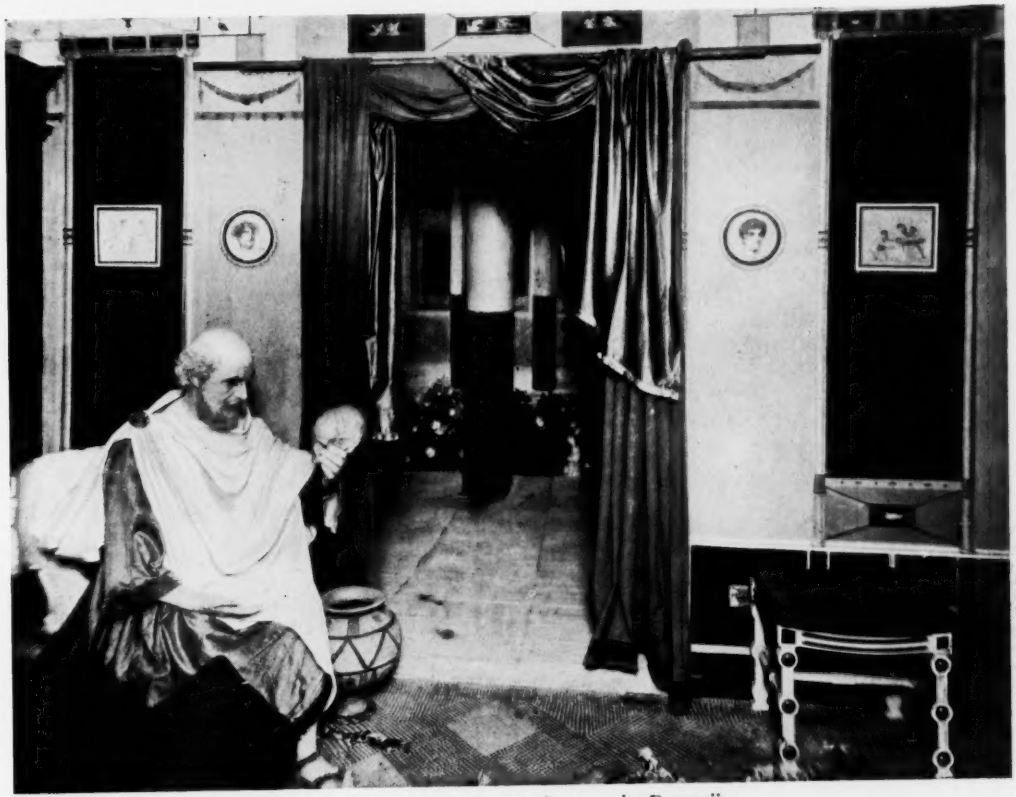


FIGURE 394. A Roman Surgery in Pompeii.

XUM

FIGURE 395. Liebig's Laboratory.

FIGURE 396. An Alchemist's Laboratory.

in their own bodies, and with the belief that by the simple process adopted they would be cured.

Adjacent to this exhibit, and coming like it from tropical countries, we have quite the latest development of modern zoölogical medicine; for arranged under microscopes are slides illustrating the most important Protozoa which cause disease, and on the walls are maps, diagrams, and pictures showing the past history and present knowledge of malaria, yellow fever, sleeping-sickness, and other diseases which make themselves felt in hot climates.

Exceedingly interesting is the series of portraits and relics of Dr. Edward Jenner, the discoverer of vaccination, which are in an alcove of the Gallery of Pictures, and, indeed, not the least remarkable part of the collection is that devoted to celebrated medical men.

Returning to the bacteriological side we are reminded again and again of the great benefits of antiseptic surgery. At the same time there are many pictures of operations performed in ancient days which proved perfectly successful. In this connection it may be mentioned that not a few of the exhibits indicate what operations were like before the introduction of anaesthetics. One peculiar feature of the representations, whether they be of operations, of post mortems, or of birth chambers, is the large audience that has collected together in most of the cases.

As may be expected, a fair amount of space is devoted to surgical instruments and their evolution, but it must not be thought that there is not an immense amount of material of general interest. There is an excellent selection of charms and talismans, including many Egyptian amulets, and a feature which we have chosen to illustrate here by the courtesy of the Museum Committee is the reconstruction of ancient shops and laboratories. On page 375 we show the barber surgeon's shop, the ceiling of which is decorated with bleeding-dishes. Below, on the same page, we reproduce a photograph of a Roman surgery in Pompeii, which has been reconstructed for the Historical Medical Museum, and the furniture and decoration of which have been copied from the originals found in Pompeii and Herculaneum. On page 376 is depicted Liebig's laboratory, and also that of an alchemist.

Other points of special interest on the ground floor are the representation of a lying-in room of the sixteenth century, the chapel showing votive tablets, chiefly from Perugia, which were offerings put up out of gratitude by those who had recovered from accidents or disease during the seventeenth, eighteenth, and nineteenth centuries. We must not forget to mention also a London pharmacy of the eighteenth century. The shop front is the original of that established in 1798 by John Bell, the founder of the Pharmaceutical Society. The room at the back contains the actual fittings from a pharmaceutical laboratory of the eighteenth century which once stood in Russell Street, Covent Garden.

It would be impossible within the limits of a single article to give a really comprehensive account of all that Mr. Henry S. Wellcome and his able assistant, Mr. C. S. Thompson, have got together, but we may mention a few things which have attracted our attention during our visits to which allusion has not yet been made.

Among the very many pictures are representations of Ambroise Paré using the ligature when amputating on the battlefield at the siege of Baravilliers in 1552; of William Gilbert demonstrating the magnet before Queen Elizabeth; of William Harvey explaining his theory of the circulation of the blood to Charles I; and of Leeuwenhoek with his microscope. Elsewhere there is a fine collection of early microscopes, which alone would be worth a visit to the Museum.

A case not mentioned in the catalogue contains the shirt, drawers, and garters worn by Charles I on the scaffold, together with touch-pieces, mostly nobles from the reign of Henry VIII onwards, used in connection with touching for king's evil.

The frieze in the gallery of pictures represents the sculptured reliefs in the birth-house at Luxor illustrating the birth of Amenophis III, 1450 B.C.

In the gallery devoted to books, manuscripts, and diplomas we find a demand from the Rector and Council of the University of Pavia to the Inquisitor of Witches. It appears that the anatomical department of the University was entitled to the body of one malefactor every year, but that they had not had one for six years; and hearing that a woman had been sentenced to be burned alive for witchcraft, the authorities applied to the Inquisitor, requesting him to choose some other method of killing her, so that her body might be useful, not only to the University of Pavia, but to the world at large.

We are shown also the contents of the opium den raided in the east end of London which previously had furnished Charles Dickens with his references to opium smoking in "The Mystery of Edwin Drood." The evolution of the infant's feeding bottle from a cow's horn is illustrated, and there are some interesting models of and original parturition chairs. A Sicilian one of the latter, dating from the eighteenth century, was believed to possess special powers, and was known as "The Miraculous Chair of Palermo." It was in the possession of a famous family of midwives for three generations, and it is estimated to have been used in two thousand cases.

With the instruments of torture we find a number of appliances used for restraining the insane from the fifteenth to the eighteenth century. There are ancient weights and measures, and a collection of curious materials used in medicine. It is understood that the Museum will be made a permanent one, as a great many of the objects belong to Mr. Wellcome or have been presented, while a number of those who have lent specimens will allow them to remain for some time on exhibition. The Museum is not open to the public, but members of learned societies can gain admission.

XUM

THE NATURE OF X-RADIATION.

By W. F. D. CHAMBERS, B.A. CANTAB.,

Barrister-at-Law.

(*For Illustrations, see Page 390*).

Is the universe a liquid or "flowing crystal" in process of transformation, with varying acceleration, to the solid or cubic state?*

Daring as such a speculation may appear to-day, its analogies are almost involuntarily suggested by recent developments in optics and crystallography; and speculation (in leisure hours) gives a zest to science.

Even the older physics and astronomy taught us that it was not improbable that the sidereal universe might be tending, under laws of conservation and dissipation, to a uniform diffusion of heat, a *rigor mortis*, in which there should exist no longer the restless surge of potential differences which is responsible for the grand drama of life and evolution.

Coming now to sober facts, it will be familiar to your readers that the X-rays, hitherto supposed to be subject neither to refraction, diffraction, nor deflection by magnetic fields, have at last yielded to the seductions of crystalline substances, as the present writer predicted they would four years ago. From the year 1905 a particulate theory of the aether, or medium supposed to pervade space, has been advocated, and it was proposed that light, in some forms at least, might consist of polar particles, or self-satisfying doublets, which neutralise *inter se* their chemical valencies, and, even in a high degree, their susceptibility to external stress. The X-rays, and at first the alpha particle of helium, emitted by the radium atom undergoing transformation, were supposed to be among these forms. This hypothesis, first published in *The Journal of Downside College*, 1907, was later sketched as a general theory of Energy-Action in the *Scientific Monthly Magazine*. The distinctive geometrical feature of the attempt was the use of Gregory St. Vincent's principle of the quadrature of the hyperbola, which curve in its rectangular form was supposed to furnish a limit to the excursions of light and cathode particles, when the curve is transformed to polar coördinates, and rotation round an axis is supposed added to the motion. Professor Bickerton, quite independently of the writer, has made use of a similar geometric scheme for his Kinetol, *vide* "Birth of Worlds and Systems," 1911, page 17.

Benoist [*Journal de Physique* (3), X, 1901, page 653, and elsewhere] has shown that when X-rays are allowed to fall upon various metallic surfaces after passing through a standardising prism of paraffin, the molecular weights plotted against the absorptions seem to approximate to such a curve, and this law of absorption (which must correspond with a redistribution of material particles) is independent of temperature. Furthermore, there is reason to think that individual series of compounds are susceptible of treatment in the same way, especially as regards their critical changes at high temperatures. We may also recall the fact that in his original experiments on the modifications of light produced by narrow apertures Newton found that the shadows produced by knife-blades placed in the path, approximated to rectangular hyperbolas the more nearly the edges were brought together.

Professor Bragg has given the more complete expression of the doublet theory of X-radiation, and Tutton has dealt with the conception in its wider application in his work on crystals ("International Science Series"), where he illustrates the various internal and external forms which may be produced by "astatic" or moving magnetic fields.

It has also been pointed out that such a theory of the ultimate significance of Mendeléef's famous principle of periodicity would probably lead us to suspect a composite nature of hydrogen, which might be considered as a primary doublet, or perhaps connected with the terrestrially unknown gases coronium and nebulium; and now Sir J. J. Thomson has given grounds for believing in the possibility of some such modification of Prout's hypothesis. Hydrogen, if not composite, is at least capable of some extraordinary action with neon.

It must not, however, be supposed that such speculations are opposed fundamentally to the undulatory theory of light. The discoveries of Perrin in connection with the "Brownian movements" in fluids in no way invalidate tidal theory, though they tend to show that water may be considered from another, and perhaps deeper, point of view than that which treats of the unresolved motion of its particles, or movements *en masse*. The mechanism of ripples or "pulses" in aether may in like manner be shown to be subject to general laws of arithmetical and geometrical progression in the distribution of constituents, and yet this need by no means change the law of averages, the differential equations of the group effects. Similarly we assert nothing of the movements of individual birds in a flight or of bees in a swarm merely because we see numbers of them together moving as if they had no purpose or aim in their random wanderings on behalf of nest or hive. Indeed there are cases where

* Some recent theorists have sought to reduce even colloids to a crystal basis.

such aggregates of moving individuals, *e.g.*, the spiral nebulae, will appear perhaps like a stationary or wavy streak of cloud maintaining a fictitious appearance of rest during long periods; and yet they are in all probability the seat of turbulent centrifugal action the ends of which it will take aeons to discern.

Professor See, of Mare Island, California, in his recent monumental work on the nebular theory, maintains that he has adduced evidence that the older forms of these mysterious germs of worlds approximate to the Archimedean form of spiral, the later tending to the logarithmic. These curves can express respectively arithmetical and geometrical progressions such as Perrin found; and it is noteworthy that upon any such theory of gravitation, as a residual mode of energy, as that of Lorentz a resistance varying in the inverse square must be added. Professor See in a recent letter to the writer suggests that sufficient attention has not yet been given to such attempted correlation; such was also the opinion of Poincaré. It appears not improbable that free electrons passing through atoms, or some stars, such as 1830 ϵ Groombridge, through globular clusters, would do so, not upon long ellipses, but rather on elliptiform helices, their orbital motion being gradually damped while passing through the centre of the cluster. Yet in no science must we be more vigilant against spurious appearances of irregularity or regularity than in optics. In that science a speculative element is positively a saving grace; as Faraday expressed it: "That man only is condemned who cherishes fixity of opinion." Do not the canals of Mars teach us a like lesson, that these questions of law or ultimate expressions of fact are still open to faith in a beneficent and volitional purpose?

In pursuance of such ideas Mr. Rankin and the writer have recently (*Nature*, June 19th and August 21st, 1913) been able to show that X-rays are "diffracted," or at least characterised by contact or close proximity to metals as well as "crystals," and even by substances such as plate glass (see Figure 411), which must be regarded as either structureless or at least in a transitional stage, seeing that it is a super-cooled liquid. Some of these effects have also been obtained through cast, as well as wrought, iron plates (up to one centimetre in thickness), used as obstacles without apertures, showing a geometrical pattern on special rapid plates which can scarcely in all cases be attributed to the mechanical rolling of the metals. It seems not improbable (see Figure 410) that the primary beam of X-rays has undergone some displacement or shift, as though it were subject to some repulsive agency which begins to act perceptibly at short distances, effects which are visible only to the photographic eyes of science. In this experiment a thin lamina of mica was used to cover the aperture in a lead screen, and was placed at an angle of 85° to the rays. The curious bands upon the reflected portion of the beam are still, we believe, unexplained. A series of upwards of two hundred experiments has been made with the object of throwing light upon some of the obscure questions raised by the recent reflection of X-rays. A short résumé only of the results can be given in the present article.

Halos, similar to those of Figures 406 and 407, were obtained both with and without mica, or other crystal used to cover the apertures, which were generally about a quarter of an inch in diameter, in metal screens, lead, iron, brass, and others. One hypothesis of these halos attributes them to atmospheric secondary radiation. They are probably not halation effects, though if this were the case it would be tantamount to a reflection of X-rays from a glass, *i.e.*, a non-crystalline surface, the back of the "special rapid" plate. The term "halo" is carelessly used by photographers, and should we think be confined to appearances such as Figure 406, where the feature is independent of the image of the direct rays; in Figure 407 the white band alone secures the effect from being possibly due to secondary radiations, or some cause not implicating the primary rays. In experiments (see Figure 409) to study the disposition of the reflected spots from mica placed normally to the aperture in an iron screen it was found in several cases that these markings occur at increasing distances from the centre, indicating a spiral sequence; the exterior spots not well seen in the reproduction, appear elongated or drawn out into bands which are not concentric. Figure 408 shows one arm of a bright cross which had appeared on one negative where no mica or crystal had been interposed in the aperture of an iron screen. This cross covered the whole plate, *i.e.*, extended beyond, and was apparently independent of, the image of the aperture, and suggested a possibility that the primary rays might possess some structure or be polarised or quenched in special directions by the use of certain crystals. But in further experiments black bands parallel and normal to the arms of a cross were obtained even with the direct or uninterrupted rays received upon a plate within a wooden box containing an intensifying screen. This raised the question whether these bands might not be purely photographic effects due to some development errors or the mechanical process of plate manufacture, though plates of various makers had been used and all the non-essentials of the experiment repeatedly changed. A crucial trial was therefore devised to determine how far photographic errors could effect the general results, and this showed that the possibility of vibrations at right angles to the plate in process of manufacture causing inequalities of disposition of the sensitive material in process of drying, must be taken into consideration This particular effect could not be due to a primary structure of the X-ray beam, *i.e.*, a structure antecedent to all obstacles, such as metallic crystals, whether in the wires, anti-cathodes, or glass of bulb or plates. The experiment was arranged as follows. Four recording plates, two made by the well-known

XUM

Ilford Company, and two by the Imperial Plate Company, of Cricklewood, were placed parallel, one behind the other and a thick lead screen. The plates were normal to the rays, but their edges were at various angles to the horizontal, none of them being the "way" of the plate-process. The distance between the plates was a few centimetres, and that of the first plate to the platinised-nickel anti-cathode of a water-cooled X-ray bulb was fifty centimetres. A constant current of ·7 milliampere was passed through the bulb, and the exposure continued for eleven hours. Dark parallel bands showing a crossed system appeared on all the plates, but these are not, as they should be if one continuous form or structure of radiations had been transmitted through the series, in some one definite relation to the images of three small circular apertures in triangular form which had been made in the lead screen. Similar bands, however, in so many other experiments have been found in a definite quadrilateral pattern that *chance* variations in the plate process or in development can scarcely be the cause, though some *definite* variations causing an inequality of absorbing substance may be. It appears that such causes varying the effect must be considered as one of the inevitable disadvantages of the photographic method, which even in the case of experiments with crystals, giving reflections or spots of variable form, should be checked by such devices as we have used, or even by the ionisation method. Mr. Keene, in a recent letter to *Nature*, seems to suggest the convertibility of the spots and bands by the mechanical structure of rolled metals.

Inference is either direct or indirect. A thoroughly instructive experiment does not allow one to escape its lesson. But there is another kind of inference, less trustworthy, but still necessary, to guide research, which demands theoretical knowledge or ingenious insight into analogy. No doubt one must first adopt the method of frontal attack which leads to the inevitable form of inference, yet afterwards probabilities or speculative suggestions may be tolerable or even useful.

Now, if the X-rays are simply light, the reasons which may compel them to appear different may be: (1) that the velocity is higher; (2) that the mass of the constituent rays or particles may be greater, the total momentum being higher on one or other of these grounds. I prefer to suppose that it is the velocity, considered as a function of the inertia or primary property of resistance, which is greater than that of ordinary light.* It does not appear that experiments have yet rendered untenable this reduction of light and matter to one and the same substantial theory of electrical resistance. If not, it may form a simple aim or guiding hypothesis which, being proven, would constitute an advance towards the simplicity of generalisation. One or two salient facts which tend in support of such a theory may be mentioned here, not because they prove it, but rather that they are steps on the way. Thus the writer found, following Tribe and Leduc, that if a small quantity of potassium ferri-cyanide be compounded with gelatine, and the mass subjected to electric currents of low voltages, coloured rings appear in the gelatine round the electrodes, and these rings are undoubtedly due to the transport of ions from one pole to the other after the chemical dissociation of molecules. In one case a clear-cut impression like a seal or intaglio was obtained round the zinc electrode as though matter had been actually scooped out and transferred to the other pole. Also Scheffer, of Berlin, has recently shown that probably particles of silver bromide in the gelatine of such plates as were used for these X-ray experiments explode and emit daughter particles having filaments connecting them to the parents. It seems reasonable to expect that there should be for freed electrons some lateral principle of limitation of the distribution answering to the vertical geometrical progression discovered by Perrin for the arrangement of small particles in fluids. For instance, he found (*vide* "The Brownian Movement and Molecular Reality," translated by F. Soddy, F.R.S., page 42) that the concentrations of granules were determined in five equidistant planes, the numbers being 100, 116, 146 170, and 200, whereas the numbers 100, 119, 142, 169, and 201, which do not differ from the preceding by more than the limits of an experimental error, are in geometrical progression, the altitudes (represented in Gregory Vincent's construction as areas or volumes) being in arithmetical progression. This is also suggested to the ordinary observer by the form of the smoke from volcanoes in still air, which spreads out into a flat plate bounded on the undersurface by what resembles a hyperbolic curve. Such a principle, if based on numerical experiments such as those of Perrin, with the granules of X-ray plates, might tend in the direction of setting free the logarithmic or hyperbolic curve from the special mode of energy-action we know as gravitation, giving us a counter-principle of levitation or atomic-segregation through the cosmos acting, in general, contrary to weight, which is conformable to much recent research and speculation, including Professor Bickerton's new astronomy.

* This view was first expressed by the writer before Kaufmann and Abraham had given experimental evidence of it for Cathode particles. *Vide* "New Theories in Biology," *Zoological Record*, 1899, where it is called the principle of "Cumulative inertia."

THE FACE OF THE SKY FOR NOVEMBER.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 65.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Uranus. R.A.	Uranus. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Nov. 1	14 24·4	S.14·3	17 3·0	S. 28·0	15 56·6	S.23·3	12 53·8	S. 4·0	7 30·1	N.23·1	18 56·3	S.23·1	5 5·4	N.21·1	20 24·9	S.19·9	8 1·0	N.20·1
,, 6	14 44·1	15·9	21 39·2	S. 16·9	16 15·7	24·1	13 16·8	6·4	7 35·9	23·1	18 59·8	23·0	5 4·2	21·1	20 25·3	19·9	8 1·0	20·1
,, 11	15 4·2	17·3	1 13·2	N.10·3	16 26·4	24·1	13 40·1	8·7	7 40·7	23·1	19 3·5	22·9	5 2·8	21·0	20 25·7	19·9	8 0·9	20·1
,, 16	15 24·6	18·7	5 29·7	N.28·3	16 22·8	23·0	14 3·7	11·0	7 44·3	23·2	19 7·4	22·8	5 1·4	21·0	20 26·3	19·8	8 0·7	20·1
,, 21	15 45·4	19·9	10 14·0	N.12·9	16 2·8	20·6	14 27·7	13·1	7 46·7	23·3	19 11·5	22·7	4 59·8	21·0	20 26·9	19·8	8 0·5	20·1
,, 26	16 6·5	S.20·9	14 35·5	S. 19·4	15 37·2	S.17·7	14 52·2	S. 15·1	7 47·7	N.23·5	19 15·7	S.22·6	4 58·1	N.20·9	20 27·6	S.19·8	8 0·3	N.20·1

TABLE 66.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Mars. P	Mars. B	Mars. L	Mars. T	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	h. m.	°	°	°	°	h. m.	h. m.
Nov. 1	+24·6	+4·3	312·5	+ 5·5	−14·4	+9·4	15·0	10 58 *m*	−6·8	−1·5	304·5	292·4	1 32 *e*	1 53 *e*
,, 6	23·7	3·7	246·6	−17·7	13·6	9·8	328·2	2 10 *e*	7·2	1·4	12·8	322·6	9 30 *e*	1 3 *e*
,, 11	22·6	3·2	180·7	−20·9	13·0	10·0	281·7	5 22 *e*	7·6	1·4	81·2	352·7	7 38 *e*	0 13 *e*
,, 16	21·2	2·6	114·7	− 3·1	12·5	10·1	235·3	8 32 *e*	8·0	1·4	149·4	22·9	5 46 *e*	9 19 *e*
,, 21	19·7	2·0	48·8	+19·4	12·1	10·1	189·3	11 41 *e*	8·4	1·3	217·7	53·0	3 54 *e*	8 29 *e*
,, 26	+18·0	+1·4	342·9	+17·1	−12·0	+10·0	143·5	2 11 *m*	−8·8	−1·3	285·9	83·1	2 2 *e*	7 39 *e*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Mars, T is the time of passage of Fastigium Aryn across the centre of the disc. In the case of Jupiter, L_1 refers to the equatorial zone; L_2 to the temperate zones; T_1, T_2 are the times of passage of the two zero meridians across the centre of the disc; to find intermediate passages apply multiples of $9^h\ 50\frac{1}{2}^m$, $9^h\ 55\frac{1}{2}^m$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

The asterisk indicates the day following that given in the date column.

THE SUN continues his Southward march, but with slackening speed. Sunrise during November changes from 6.53 to 7.44, sunset from 4.35 to 3.53. Its semi-diameter increases from 16′ 9″ to 16′ 15″. Outbreaks of spots in high latitudes should be watched for.

MERCURY is an evening star till 23rd. It reaches greatest elongation (23½° E) on 2nd, but, being South of Sun, is not well placed for observation by Northern observers. Illumination diminishes from $\frac{8}{9}$ to Zero, then increases to $\frac{1}{12}$. Semi-diameter increases from 3″ to 5″.

VENUS is a morning star, rising 2 hours before the Sun. Semi-diameter diminishes from 5½″ to 5¼″. At beginning of month $\frac{9}{10}$ of disc is illuminated; at end of month $\frac{1}{20}$. Being North of Sun it is favourably placed for Northern observers.

THE MOON.—First Quarter $5^d\ 6^h\ 34^m\ e$; Full $13^d\ 11^h\ 11^m\ e$; Last Quarter $21^d\ 7^h\ 56^m\ m$. New $28^d\ 1^h\ 41^m\ m$. Apogee $9^d\ 4^h\ m$, semi-diameter 14′ 46″. Perigee $25^d\ 6^h\ m$, semi-diameter 16′ 22″. Maximum Librations, 1^d 7° N, 2^d 7° W, 16^d 7° S., 17^d 5° E, 29^d 7° N, Dec 1^d 6° W. The letters indicate the region of the Moon's limb brought into view by libration. E. W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 67).

TABLE 67. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1913.			h. m.		h. m.	
Nov. 1 ...	BAC 5838	6·8	4 51 *e*	129°	—	—
,, 5 ...	27 Capricorni	6·1	6 12 *e*	31	7 22 *e*	269°
,, 8 ...	BAC 8129	6·3	3 39 *e*	101	4 31 *e*	195
,, 14 ...	66 Arietis	6·1	6 29 *m*	118	7 11 *m*	223
,, 16 ...	BD+27°880	7·0	—	—	5 31 *e*	248
,, 16 ...	136 Tauri	4·6	6 1 *e*	103	6 49 *e*	242
,, 18 ...	47 Geminorum	5.6	2 8 *m*	79	3 20 *m*	304
,, 18 ...	BAC 2383	6·5	5 38 *m*	27	5 49 *m*	9

From New to Full disappearances take place at the Dark Limb, from Full to New reappearances.

XUM

MARS is a morning Star, in Gemini, semi-diameter 6″, defect of illumination over a second. It passes its stationary point on November 27th, and will reach Opposition early in January, so the season of observation has commenced. The North Pole is now turned towards us.

JUPITER is now very low in the West. Polar semi-diameter, 16″ in mid-November.

TABLE 68.

Day.	West.	East.	Day.	West.	East.
Nov. 1	413 ○	2	Nov. 16	24 ○	13
,, 2	42 ○	13	,, 17	421 ○	3
,, 3	4 ○	3 2●1●	,, 18	4 ⊙	23
,, 4	41 ○	23	,, 19	4 ⊙	31
,, 5	423 ○	1	,, 20	4321 ○	
,, 6	3421 ○		,, 21	43 ○	21
,, 7	3 ○	412	,, 22	431 ○	2
,, 8	31 ○	24	,, 23	42 ○	31
,, 9	2 ○	134	,, 24	21 ○	43
,, 10	2 ○	34 1●	,, 25	○	1243
,, 11	1 ○	234	,, 26	○	234 1●
,, 12	2 ⊙	14	,, 27	231 ○	4
,, 13	321 ○	4	,, 28	3 ○	14 2●
,, 14	3 ○	214	,, 29	31 ○	24
,, 15	31 ○	42	,, 30	2 ○	14 3●

Configuration at 5^h *e* for an inverting telescope.

Satellite phenomena visible at Greenwich, 1^d 7^h 55^m I. Oc. D., 8^h 0^m II. Tr. I.; 2^d 5^h 11^m I. Tr. I., 6^h 21^m I. Sh. I., 7^h 30^m II. Tr. E.; 3^d 5^h 50^m 20^s I. Ec. R., 7^h 56^m 52^s II. Ec. K.; 5^d 6^h 44^m III. Sh. E.; 9^d 7^h 11^m I. Tr. I.; 10^d 4^h 24^m I. Oc. D., 5^h 31^m II. Oc. D.; 11^d 5^h 5^m I. Sh. E.; 12^d 5^h 5^m II. Sh. E., 6^h 22^m III. Tr. E., 7^h 14^m III. Sh. I.; 17^d 6^h 23^m I. Oc. D.; 18^d 4^h 41^m I. Sh. I., 6^h 0^m I. Tr. E., 7^h 0^m I. Sh. E.; 19^d 4^h 8^m 59^s I. Ec. R., 4^h 47^m I. Sh. I., 5^h 42^m II. Tr. E.; 23^d 4^h 48^m 38^s III. Ec. R.; 24^d 5^h 6^m 16^s IV. Ec. D.; 25^d 5^h 42^m I. Tr. I.; 6^h 36^m I. Sh. I.; 26^d 5^h 37^m II. Tr. I., 6^h 3^m 52^s I. Ec. R., 28^d 5^h 10^m 49^s II. Ec. R. All these are in the evening hours, the planet setting before midnight. Attention is called to the double eclipse of 3^d. The eclipses take place to the east of the disc, or to the right in an inverting telescope.

SATURN is a morning star, in Taurus, in a good position for observation. Polar semi-diameter $9\frac{1}{2}''$. P. is $-4°\cdot7$; ring major axis $47\frac{1}{2}''$, minor 21″. The ring is very widely open. It is of interest to examine the exact amount of overlap beyond the planet's pole.

East Elongations of Tethys (every fourth given), 1^d $5^h\cdot4m$, 8^d $6^h\cdot5e$, 16^d $7^h\cdot7m$, 23^d $8^h\cdot9e$, Dec. 1^d $10^h\cdot1m$; Dione (every third given), 3^d $10^h\cdot3m$, 11^d $3^h\cdot3e$, 19^d $8^h\cdot3e$; 28^d $1^h\cdot2m$; Rhea (every second given), 8^d $10^h\cdot9e$, 17^d $11^h\cdot5e$, 27^d $0^h\cdot2m$. For Titan and Iapetus E.W. mean East and West Elongations; I. Inferior (North) Conjunctions, S. Superior (South) ones. Titan, 2^d $3^h\cdot7e$ I., 6^d $0^h\cdot1e$ W.; 10^d $11^h\cdot3m$ S., 14^d $1^h\cdot9e$ E., 18^d $1^h\cdot6^d e$ I., 22^d $9^h\cdot8m$ W., 26^d $9^h\cdot0m$ S., 30^d $11^h\cdot5m$ E.; Iapetus, 8^d $8^h\cdot2m$ W., 27^d $2\cdot4^h m$ S.

URANUS is an evening star. Semi-diameter, $1\frac{3}{4}''$. At $1\frac{3}{4}°$ S. of ρ Capricorni.

NEPTUNE is a morning star, entering Cancer. Stationary at beginning of November.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
	°	°	
Nov. 1 ...	43	+ 22	Slow, bright.
,, 2 ..	58	+ 9	Slow, bright.
,, 10-12 ...	133	+ 31	Very swift, streaks.
,, 14-16 ..	150	+ 22	Leonids, swift, streaks.
,, 16-28 ...	154	+ 41	Swift, streaks.
,, 20-23 ..	63	+ 23	Slow, bright.
,, 17-23 ...	25	+ 43	Andromedids, very slow, trains.
,, 25 to Dec. 12	189	+ 73	Rather swift.
,, 30 ...	190	+ 58	Swift, streaks.

DOUBLE STARS AND CLUSTERS.—The tables of these given last year are again available, and readers are referred to the corresponding month of last year.

VARIABLE STARS.—Tables of these will be given each month; the range of R.A. will be made four hours, of which two hours will overlap with the following one. Thus the present list includes R.A. 0^h to 4^h, next month 2^h to 6^h, and so on.

TABLE 69. NON-ALGOL STARS.

Star.	Right Ascension. h. m.	Declination.	Magnitudes.	Period. d.	Date of Maximum.
SS Cassiopeiae	0 5	+51 °1	8·5 to 11·7	139·6	Sep. 6.
T Ceti	0 17	−20 ·5	5·4 to 6·9	280·6	Oct. 16 (min.)
T Cassiopeiae...	0 19	+55 ·3	6·7 to 12·5	443·0	Oct. 7.
TU Cassiopeiae	0 22	+50 ·8	7·7 to 8·5	59	Oct. 29.
TU Andromedae	0 28	+25 ·5	7·7 to 11	317	Oct. 27.
RX Cephei	0 43	+81 ·5	7·4 to 7·9	130	Oct. 24 (min.)
RV Cassiopeiae	0 48	+46 ·9	8 to 13	327	Oct. 24.
Z Ceti	1 2	− 1 ·9	8·8 to 13·5	184·5	Oct. 6.
S Piscium	1 13	+ 8 ·5	8·2 to 14·7	404·45	Sep. 6
X Cassiopeiae	1 51	+58 ·8	8·4 to 12 2	367·0	Nov. 22.
R Arietis	2 11	+24 ·7	7·5 to 12·7	186·66	Sep. 12.
R Ceti	2 22	− 0 ·6	7·5 to 12·8	166·88	Oct. 20.
U Ceti...	2 30	−13 ·5	6·6 to 12·7	235·2	Dec. 8.
R Trianguli	2 32	+33 ·9	5·9 to 11·1	265·4	Dec. 27.
Y Persei	3 22	+43 ·9	8·2 to 10·4	254·9	Nov. 2.

β Lyrae minima Nov. 8^d $5^h e$, 21^d $3^h e$, Period 12^d $21\cdot8^h$.

Algol minima Nov. 5^d 2^h $8^m m$, 7^d 10^h $57^m e$, 10^d 7^h $46^m e$, 13^d 4^h $35^m e$, 28^d 0^h 40^m *m*, 30^d 9^h $29^m e$, Period 2^d $20\cdot8^h$.

XUM

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

THE NUMBER OF VISIBLE STARS.—The enquiry as to the number of stars in the entire heavens that can be seen with our best telescopes, or photographed by them, is a very interesting one. Various estimates have been given at different times, some going as high as a thousand millions, but it now appears that this number is greatly in excess of the truth. Naked-eye observers are often surprised on hearing that they can seldom see more than two thousand stars at a time. In the same way, when one has seen some of the rich fields of the sky in a large telescope, with the whole region thickly studded with stellar points, one is apt to make extravagant estimates of the number in the whole sky. Mr. R. H. Tucker has a paper in *Publications of the Astronomical Society of the Pacific* for August, in which he gives, by the collation of various authorities, the number which can be seen visually (*i.e.*, down to the 17th magnitude) as forty million, or a thousand to the square degree. This is about the same as the number of inhabitants of Great Britain. He gives the number that can be photographed (*i.e.*, down to the 20th magnitude) as a hundred millions. It is well known that the relative increase in number for each additional magnitude falls off for the fainter stars, indicating either an absorption of light in space or our actual approach to the limits of our system. In any case, the number given must be less than the real number of stars in our system, for there are many stars of small intrinsic luminosity which are faint even when near us, and would be invisible in the more remote parts of the system. Of course, no account can be taken of dark, burnt-out stars, as we have no means of forming an estimate of the number of these. If we suppose the star density to remain constant throughout our system (which is probably not true) and take the number of stars within sixteen light-years as eighteen, then a hundred million stars would fill a sphere of radius three thousand light-years, which is the same value as Newcomb's for the distance of the outer parts of the Galaxy. But the value rests on such doubtful assumptions that it is only a rough guess.

The same publication contains an article by H. D. Curtis on the unit to be used for stellar distances. He advocates the continuance of the use of the light-year, instead of the astron or parsec, on the grounds that it is more easily grasped by the general reader, and also that it is known to one part in ten thousand, or ten times as accurately as the solar parallax. As regards the first point, I do not think that anyone proposes to drop the light-year for popular purposes; the second does not seem to me to carry much weight, in view of the fact that star-distances can only be found in terms of the sun's distance, and also that no stellar parallax is trustworthy to more than two significant figures. The parsec is advocated because it enables us to pass almost instantaneously from parallax to distance, thus saving a large amount of mental arithmetic.

There is one point in his paper which gives some food for thought: he speaks of the light-year as being six *trillion* miles. This is an instance of the American system that calls a thousand millions a billion, a thousand billions a trillion, and so on. The English system makes a million millions a billion, a million billions a trillion, and so on. It has the logical advantage that the bi-, tri-, and so on, express the powers to which a million is raised, whereas the prefixes are meaningless on the American system; moreover, there is the important advantage that fewer new names are introduced in the expression of large numbers. The adoption of a uniform system of arithmetical notation throughout the world seems a more important matter than the question of the relative advantages of the light-year or the parsec.

GIANT AND DWARF STARS.—Professor H. N. Russell gave an interesting address on this subject at the June meeting of the Royal Astronomical Society, and a summary of it appears in the *Observatory* for August. He takes all the stars for which parallaxes worthy of any confidence have been obtained, and classifies them according to intrinsic brightness and spectral type. He concludes that all the intrinsically very faint stars are red, of spectral type K or M, while all the stars of types A, B are much brighter than the sun. There are, however, a number of red stars that are intrinsically very bright, such as Arcturus, Aldebaran, Antares. The stars of types K, M are either much brighter than the sun or much fainter. Of the dwarf stars of class M not one is visible to the naked eye, although one is the second nearest star in the heavens.

Discussing the masses, he gives reasons for supposing that these differ among themselves much less than the intrinsic brightness, and that the dwarf stars are those of very low surface brightness.

He conjectures that the giant red stars are at an early stage of low temperature, low surface brightness, low density, great surface, and consequently great total light. As each contracted it would grow hotter and whiter, but smaller, so that its total light would not change much. When hottest it would have a spectrum of type A or B; only massive stars would attain the highest temperature, and stars of types A, B are found to be massive in those cases where their mass can be determined. After passing the maximum temperature it would grow smaller, redder, and duller, *i.e.*, it would pass to the class of dwarf stars. According to this view the difference between giants and dwarfs is not one of total mass, but of age and degree of condensation. It is, of course, rather curious that stars in such different conditions should give the same type of spectrum, *i.e.*, that type M should occur both at the beginning and the end of a star's career; but the evidence seems strong that these M stars do form two different classes.

Professor Russell hopes to publish his researches more fully next year, and we may look forward to their appearance as likely to throw new light on the life-history of the stars.

A NEW COMET.—The second comet of the year was found by Dr. J. Metcalf, on September 2nd, being his third discovery of the kind. It was of the tenth magnitude, in Right Ascension $6^h\ 50^m$, North Declination 57°. Daily motion minus $1^m\ 16^s$, North 34′. If an ephemeris for October should be ready in time, it will be given in another column, with "Face of the Sky" for November.

Later.—The comet was nearest to the Sun on July 20th, but approached the Earth in September so as to grow slightly lighter; but it will not be conspicuous. Another faint comet was found by Neujmin on September 3rd.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

BOTANY AT THE BRITISH ASSOCIATION.—The doings of Section K (Botany) at the Birmingham meeting presented various features of interest. For the first time in the history of the British Association, a lady was chosen as President of a Section, and in her address Miss Ethel Sargant referred in felicitous terms to this innovation as an honour done to herself as a botanist, but also as an act of generosity—greater because done in the face of custom and prejudice.

RECENT RESEARCH ON EMBRYOLOGY OF ANGIOSPERMS.—Miss Sargant, after a tribute to the work and influence of the late Lord Avebury, as a representative of a small but distinguished class of naturalists, to whom she

XUM

referred as "the salt of the subject, preserving it from the worst effects of a purely professional and academic standard," gave an interesting account of the development of botanical embryology since 1870. As might have been expected from the large share which the President herself has taken in the investigation of seedling structure in Angiosperms and its phylogenetic interpretation, the address was limited to Angiosperm embryology, though this is, of course, in itself a sufficiently wide field. As pointed out by Balfour, embryology ought, strictly speaking, to deal with the growth and structure of organisms during their development within the egg-membranes before they are capable of leading an independent existence, but modern investigators have shown that such a limitation of the science would have a purely artificial character, and the term "embryology" is now employed to cover the anatomy and physiology of the organism during the whole period included between its first coming into being and its attainment of the adult state. The older botanists used the term in the narrower sense, including the study of the embryo-sac and the structures contained in it before the formation of the unfertilised egg-cell as well as the fertilisation of the latter and its subsequent divisions, but they did not proceed beyond the resting stage of the embryo within the ripe seed. Here, as in zoölogy, this division is arbitrary and inconvenient; hence in the following remarks embryology is taken to include every stage in the development of the plant from the first division of the fertilised egg-cell to maturity.

Systematists from Caesalpino onwards have paid much attention to the structure of the seed, and were indeed forced to study the embryo because its characters are often of systematic importance; for instance, the number of cotyledons is the most constant character separating the two great classes of Angiosperms, while the presence or absence of endosperm in the ripe seed, besides being important systematically, determines the function of the cotyledons after germination, and thus influences their structure profoundly. Hence botanists became familiar with the structure of the embryo in the ripe seed before they had traced its origin from the fertilised egg-cell, or followed its development after germination. Since the early history of the embryo was a sealed book to observers without the compound microscope, work on the external morphology of seedlings preceded that on the formation of the embryo. In the school of seedling descriptive work the greatest name is that of Thilo Irmisch (1815–1879), whose work was neglected by the succeeding generation owing to the rapid development of microscopic botany, starting from Hanstein's classic work (1870) on the divisions of the fertilised egg-cell, which laid the foundation of botanical embryology in the narrower sense—the study of the embryo from origin to germination. The period in the plant's history beginning with the first division of the fertilised egg (a natural epoch, since a new generation dates from it) and ending with the formation of the ripe seed (a true physiological epoch, since it corresponds with a complete change in the conditions of life) would seem very well defined; but experience has shown that here, as in zoölogy, embryologists lose more than they gain by dividing the subject in this way—one group of investigators beginning their work where the others end theirs—and that this division is neither so simple nor so natural as it appears at first sight. It is not simple because the embryo is not always completely dormant during the interval between the formation of the ripe seed and the first steps in germination. In most Monocotyledons and many Dicotyledons the embryo is an almost undifferentiated mass of meristem when the seed first ripens, and becomes differentiated internally and externally by degrees during the interval before germination: this is often called the maturation of the seed, and it is quite distinct from its ripening. Maturation is a process characteristic of the seeds of geophilous plants (plants with bulbs, corms, rhizomes and other perennating underground organs) which commonly lie in the ground for a year at least before germination; the embryo of such plants is not comparable morphologically with that in the seed of an annual which may have ripened at the same time, since the embryo of the annual has root, stem, and leaves besides its cotyledons, and is ready to germinate immediately on the return of spring. Hence the morphologist must continue his study of the geophilous embryo throughout the maturation period if he is to compare it with that of the annual; even then he will find it less advanced than the annual embryo though both be examined as they break out of the seed, for the geophyte may, perhaps, be four or five years before it flowers, while the annual has to complete its whole life-cycle in a single season. The division of the subject into two parts, the first ending with the embryo in the ripe seed, is also an unnatural one, even if the time of maturation be included in that first period; for the structure of the embryo cannot be completely understood by reference to its past alone. The observer must expect adaptive characters of three kinds:—(1) those imposed on the embryo in the past by its development within the embryo-sac while it is still parasitic on the parent plant; (2) certain adaptations to the process of germination itself; (3) characters which will be useful after germination. Before the utility of these characters can be fully understood the development of the seedling must be followed for some time. In short, the structure of the embryo is dependent upon its future as well as on its past, and a division of the subject which excludes that future is, as Balfour says, purely artificial.

The work done in recent years on the anatomy of the seedling has therefore not only completed Irmisch's work on its external morphology, but has also thrown light on the problems of early embryology, attacked by Hanstein and his immediate followers. These problems are of two kinds, relating to the internal anatomy or the external morphology of the embryo. Hanstein himself was chiefly interested in the former, and his work disposed once for all of the possibility that the embryo of Angiosperms might possess an apical cell in the earlier stages of its growth as a reminiscence of its cryptogamic ancestry. One general result of work on the embryo since Hanstein's time has been to discredit phylogenetic theories based on its early history; indeed, it was hardly to be expected that a small mass of meristem, developing within a confined space and feeding parasitically on the tissues of the mother-plant, should preserve ancestral features. Still, Hanstein and his successors did good service in elucidating the growth of the pro-embryo from the fertilised egg-cell; its division into suspensor and embryo; the general development of both, and the appearance of external and internal differentiation in the embryo before germination.

While some of Hanstein's general conclusions as to internal anatomy have become the common property of text-books, for instance, the early differentiation of the dermatogen and its subsequent development into the epidermal system, he was less successful in demonstrating the initial independence of plerome and periblem, and their relation to the vascular system of the mature stem. The early differentiation of plerome and periblem from the inner tissues of the embryonic axis and their continued formation at the growing-points of root and shoot are processes which demand the most careful investigation on account of their bearing on the stelar hypothesis.

(To be continued.)

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

TESTING THE VITALITY OF SEEDS.—An ingenious method of ascertaining whether a seed is living has been devised by Mr. S. Tashiro, and an outline of his communication on this subject to the Eighth International Congress of Applied Chemistry is given in the *Analyst* (1913, XXXVIII, 370). The method depends upon the fact that so long as a seed is alive it liberates carbon dioxide. This gas can be detected and estimated by means of a special apparatus which is so sensitive that it can measure as little as one ten-millionth part of a gramme. It was found with the aid of this apparatus that when a living seed was crushed

XUM

or bruised its activity was stimulated, and that it then emitted a much greater quantity of carbon dioxide.

DUST EXPLOSIONS.—Interesting experiments have been made by Mr. W. R. Lang (*Proc. Chem. Soc.*, 1913, No. 168, 1911) to test the liability to explosion of finely divided starch and coal dust when mixed with air. The fine powder was allowed to fall into the upper end of a vertical glass cylinder about seven feet long by four inches in diameter. Through the sides of this open glass chamber, about half-way down, were fused two wires connected with an induction coil, so that a spark could be passed through the mixture. When this was done the dust, whether of coal, starch or lycopodium, ignited explosively; the combustion spread throughout the length of the tube, and flames issued from each open end. Analogous results were produced by applying a light to the end of the tube.

Microscopic measurements of the particles of different kinds of dust used in the experiments were made, and the average results calculated into the total areas of the substances per one hundred grammes. In this way the following results were obtained:—

Substance.	Mean diameter of particles in millimetres.	Total surface area for 100 grammes of substance.
		Square Metres.
Lycopodium powder ...	0·028	20·92
Maize starch	0·0122	32·78
Coal dust (*a*) medium ...	0·012	33·33
,, ,, (*b*) fine ...	0·0016	250·00
"Pyrophoric carbon" ...	0·00125	332·00
"Pyrophoric iron" ...	0·0054	15·08

GEOGRAPHY.

By A. STEVENS, M.A., B.Sc.

A PHYSIOGRAPHICAL STUDY IN NEW ZEALAND.—In the September *Geographical Journal* there is an account of the physiography of the middle Clarence valley, New Zealand, by Mr. C. A. Cotton. The Clarence River rises near Mount Franklin, in North Canterbury, and after flowing in a southerly direction for some forty miles, turns sharply towards the north-west, flows for fifty miles between the Seaward and (Inland) Kaikoura Ranges, and is again sharply deflected to the south. The paper in question discusses the portion of the course which lies between the Kaikouras.

The geology of the country has not been fully worked out, and, as so frequently happens in New Zealand, presents some difficult and disputed questions. Generally it may be stated that the underlying older rocks are of about Carboniferous age. They are much contorted, and the system of folding has not been described. These rocks have been extensively denuded, and probably were cut down so as to present a surface of low relief. Newer deposits, of age ranging from Cretaceous to Pliocene, covered them; on a basal conglomerate rested soft mudstones, and the sequence passed up, through resistent beds of limestone and flint and soft marls, to a top layer of hard conglomerate. Earth-movements on a large scale have affected the area and produced two huge anticlines, or probably anticlinoria, separated by an asymmetrical syncline, the north-west limb of which gave way, and is represented by a reversed fault of enormous and undetermined throw. The anticlines build the Kaikoura Ranges, while the syncline has been occupied by the Clarence River, which in its middle course is therefore a consequent stream.

In the cycle of denudation which ensued, the covering of newer rocks was removed from the mountains by the streams of the Clarence system, a flat floor of mudstone being left in the valley. This lies closer to the north-west side of the valley, where it is faced by the scarp of the limestone, and the want of symmetry of the valley is a direct consequence of the asymmetry of the syncline. A subordinate uplift following rejuvenated the stream, already at base level, and it proceeded to cut a gorge in the valley floor. The courses of rivers further to the north and to the south are transverse to the middle Clarence, and consequently to the axis of the mountains, and these, Mr. Cotton considers, are antecedents, whose courses were determined by a simple regional uplift earlier than the folding. By the latter movement the Clarence alone was diverted, and only in its middle course, where the rise of the land reached its maximum. The lower Clarence follows the course of an antecedent stream. The valley slopes and floor of the middle Clarence are trenched by streams antecedent, consequent, and subsequent, some graded, some still cutting. The limestone ridge is dissected by superposed consequents from the Kaikoura Range which often join twos or threes just before clearing the ridge, and so cut out pyramidal hills of limestone rather lower than the adjacent part of the scarp. The fault-plane gives rise in places to noticeable topographical features. It facets spurs from the Kaikouras (long spurs from the Seaward Kaikouras are also faceted—but by the stream), while in the lower part of the valley it is marked by a bench, some twenty feet wide, which represents an earthquake fissure. Evidences of glaciation are wanting in the area, though it has been held that the valley is deeply ice-worn. Mr. Cotton believes that glaciers have always been absent, as they are now, for the steepness of the slopes prevents the accumulation of reservoirs of snow.

OCEANOGRAPHY OF THE MEDITERRANEAN.—An article in *Nature*, for September 4th, draws attention to the report of the Danish Oceanographical Expeditions of 1908–10, to the Mediterranean and the adjacent seas. It is found that the Mediterranean is divided into two basins by a submarine ridge four hundred metres below sea-level at the deepest points, which continues the line of Italy and Sicily to the north coast of Africa. Of these basins the western is, for the most part, two thousand to three thousand metres deep, the eastern generally deeper, soundings of more than four thousand metres having been made. The main interest centres in the movements of the water. The rainfall balances less than one quarter of the loss by evaporation, and the water-level is maintained by an inward current from the Atlantic which runs from one to three knots. As a direct consequence the pressure inside is increased, and a stream sets out towards the ocean at a speed which varies between one half and five knots. Although the temperature is uniformly so high as thirteen degrees at the depth of one thousand metres, the unusual salinity, due to excessive evaporation, raises the density of the water so much that the outgoing current is a deep one. These currents are, of course, affected by the tides, and the warm outward current is made by the rotation of the earth to swing to the north and east in the lower strata of the Atlantic. This may explain the occasional high salinity in enclosed seas on the British coasts. Again, the high precipitation in the area which feeds the Black Sea and the Sea of Marmora makes these waters remarkably poor in salts, and conditions exactly opposite obtain. But the threshold of the Black Sea is so shallow that the deeper layers of the water are stagnant, and the dissolved gas is hydrogen sulphide; hence only some forms of bacteria people the sea. The water-circulation within the Mediterranean is complex and incompletely described. It varies at different depths and in different areas.

STUDIES IN GLACIERS.—From data, more or less complete, covering a period of some dozen years, one might conclude that at present there is a general tendency to retreat of the ice-fronts of the glaciers of the world. From several parts reports come in of the extension of the length of glaciers, but the figures require careful scrutiny (Hans Hess, *Petermanns Mitteilungen*, April), and when circumstances

XUM

more or less incidental are considered and the size and importance of the various ice-streams taken into account, the impression is produced that a longer period of study is necessary, and in most cases more detailed records are required. Those who make general statements covering the phenomena of the whole globe raise not unfounded suspicions that they are looking too keenly for unreasonable uniformity.

In Switzerland, if we eliminate small cirque-glaciers, which are usually in a state of oscillation, only the Lower Grindelwald glacier and the small glacier of the Sex Rouge show continued advance (*Annales de Géographie*, July, and so on). In Scandinavia in several important instances advances up to one hundred and sixty metres are recorded; but, on the whole, the glaciers are in a state of oscillation, and no general statement is justified. In Asia, New Zealand, and South America definite information is wanting, but elsewhere it is stated there is a general tendency to regression. In Alaska, however, certain of the main glaciers have pushed forward their ice-fronts, that of La Pérouse, for example, having gained four hundred metres. This growth followed upon earth tremors recorded in 1899, and has been correlated with them. Hess prefers to connect the advance with the abundant snowfalls of the end of the nineteenth century.

Joseph Vallot (*Comptes Rendus*, CLVI, May, 1913,) gives a record of temperature observations in glaciers at high altitudes (four thousand metres) made during 1898, 1900, 1911. A diurnal variation up to 13° (centigrade) is observable to a depth of ·7 metre. Down to 7·5 metres the temperature falls rapidly, and below that it varies between −12° and −13°, remaining stationary at −12·8° below fifteen metres. At the depth of about one metre, it may be concluded, diurnal temperature variation ceases, and the limit of the seasonal variation is 7·5 metres. The grain of the ice grows from ·5 millimetre to 1·2 millimetres in diameter, apparently without fusion, and the ice is impermeable. Hence neither infiltration of water nor temperature variation, which ceases at a relatively insignificant depth, can be an important factor in producing the flow of glaciers.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

GARNET AS A GEOLOGICAL BAROMETER.—The petrological investigation of a peculiar manganiferous igneous rock (kodurite) discovered by Dr. L. L. Fermor, of the Geological Survey of India, in connection with his recent survey of the manganiferous deposits of the Indian Empire, has led to certain conclusions as to the mode of formation of garnet (*Records, Geological Survey of India*, Vol. XLIII, Part I, 1913). Typical kodurite is a plutonic rock consisting of orthoclase, spandite (manganese garnet), and apatite. Associated with kodurite is a garnet (spandite) rock. In attempting to classify these rocks Dr. Fermor calculated their analyses into the norm or standard mineral composition of the American Quantitative Classification. The norm of kodurite contained orthoclase, leucite, anorthite, hedenbergite, wollastonite, tephroite, magnetite, ilmenite, and apatite; whilst that of the garnet rock was expressed as a mixture of anorthite, hedenbergite, akermanite, fayalite, tephroite, and magnetite. A comparison of the specific gravity of the mode (actual mineral composition) with that of the norm (standard mineral composition) showed that the kodurite occupied ten per cent., and the spandite rock twenty per cent., less room when crystallised as the mode than as the norm. This indicated at once that the crystallisation of kodurite and spandite rock was conditioned by high pressure, necessitating a decrease in volume as compared with the conditions of pressure under which the norms might have crystallised from the respective magmas.

If this be the true interpretation, garnet may be regarded as a geological barometer, indicating especially high pressure during its formation. Confirmation is found in the fact that garnet is an abundant constituent of all the various rocks associated with the kodurite series. Further speculation on these lines suggested that eclogite is the high-pressure form of gabbro, and consideration of the chemical analyses and the specific gravities of these rocks supported this view. Since the plutonic rocks, formed at great depths under pressure, are typically non-garnetiferous, Dr. Fermor postulates the existence below the plutonic zone of a shell characterised by garnets wherever the necessary sesquioxide radicle is present. For this shell is suggested the term *infra-plutonic*. Other minerals, notably diamond, the high-pressure form of carbon, may also be characteristic of the infra-plutonic zone, and Dr. Fermor makes the interesting suggestion that the diamond pipes of Kimberley, in which eclogites and garnets are found, may be directly connected with the infra-plutonic zone.

PRESERVATION OF PLANT-FOSSILS IN LAVA.—Some interesting examples of tree-moulds in lava are described by F. A. Perrett (*American Journal of Science*, Vol. XXXVI, August, 1913) from Kilauea. The basalt lava from this great crater has sometimes invaded a forest of trees and then flowed away, leaving an investment or casing of lava upon a tree-trunk up to a height corresponding with the greatest depth of the lava stream at that point. These are known as the *salient* or *projecting* types of tree-mould, and stand above the surrounding plain as a monument to the original tree, which, if not destroyed at once by the basalt-flood, soon dies and rots away.

In the *sunken* or *ground* type of tree-mould the lava has invaded low ground, and has come to a standstill among the trees. The latter, of which no trace now remains, have left an impression of their forms down to the minutest detail upon the lasting stone. These casts are found on the sides of cylindrical openings, from three to five metres deep, in the lava-plains. An excellent illustration in the paper shows the faithfulness of these impressions of the rugged bark of the trees upon the plastic lava. It is a matter for comment that the trees were not destroyed by their "baptism of fire," long before such impressions could be taken. If, however, the resinous varieties be excepted, large tree-trunks, massive and full of moisture, will resist carbonisation at least long enough for a skin of cold, solid basalt to form in contact with them, and thus provide a nearly non-conducting layer.

Similar plant-remains preserved in lava have been described by Solórzano and Hobson from Mexico, where fragments of maize were found in basaltic scoriae; and by H. M. Cadell, who has described a lycopod stem, twelve inches long, embedded in olivine-basalt lava from the Bo'ness Coalfield. Phenomena identical with those described by Perrett were observed by F. A. Fouqué on Etna, where the lava of the 1865 eruption flowed through a wood of lofty trees.

SAPPHIRE IN MULL.—Clear blue corundum has been found by the Geological Survey in two localities to the west of Carsaig, Mull. The mineral occurs in tabular hexagonal plates, which are, however, too small and irregular to have any gem value. In each case the crystals are found in igneous rocks which have involved xenolithic masses of sedimentary material. In one locality large xenolithic blocks of baked sandstone and shale are involved in an igneous matrix which is probably intrusive, and which encloses numerous little sapphires. In the second locality the sapphires are found in an irregular composite sill consisting partly of andesitic felsite and partly of trachytic granophyre or syenite. This intrusion is also full of xenolithic material, including baked shale. The sapphires are found both in the latter and in the igneous matrix.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

BEN NEVIS OBSERVATORY.—It is announced that a tourist hotel is being built on the top of Ben Nevis on the site of the former Meteorological Observatory. This hotel will probably be the terminus of the four and a half miles railway which it is proposed to construct when funds are assured and sanction obtained to proceed.

It will, no doubt, be remembered that the Ben Nevis

Observatory was closed at the end of September, 1904, owing to the lack of financial support. This observatory, which is four thousand four hundred and four feet above sea-level, on the highest spot in the British Isles, was established by the Scottish Meteorological Society in 1883, and observations were taken every hour, day and night, without a break, frequently under very difficult conditions, for a period of nearly twenty-one years. During the months of February and March it was not uncommon for south-easterly gales to blow for three or four days continuously at the rate of one hundred miles an hour. On these occasions the observers had to go out roped together or to crawl along the surface, otherwise they would have been blown away by the wind. At other times the rain would freeze as it fell, and so everything became coated with ice, which continued to increase in thickness almost indefinitely. During summer, or when the temperature was above the freezing-point, the fog soaked everything exposed to it, and so all the instruments outside the observatory streamed with moisture, even though no rain was actually falling; while in winter, or when the temperature was below freezing-point, the effect of the fog was to cover everything with long feathery masses of rime or crystalline specks of snow. These continued to grow to great lengths on the windward side until they broke off by their own weight. In these circumstances it was impossible to use self-recording instruments, and so the observers had to take observations every hour, day and night.

The average temperature, rainfall, amount of cloud, and hours of sunshine are as follows:—

TABLE 70.

Month.	Temperature.	Rainfall. Inches.	Cloud.	Sunshine. Hours.
	°			
January ...	24·0	18·33	8·8	22·4
February ...	23·8	13·55	8·3	42·3
March	24·0	15·25	8·4	54·7
April	27·6	8·48	8·0	80·4
May	33·0	7·90	7·8	116·3
June	39·7	7·54	7·7	127·0
July	41·1	10·80	8·6	84·9
August ...	40·4	13·34	8·8	58·1
September ...	38·0	15·74	8·3	62·2
October ...	31·4	15·42	8·5	41·8
November ...	28·9	15·36	8·5	27·9
December ...	25·2	19·07	8·7	18·0
Year	31·4	160·77	8·4	736·0

As temperature decreases approximately at the rate of 1° F. every one hundred feet, the temperature at the summit is usually about 15° lower than at Fort William; consequently the snow on the top of the mountain remains unmelted for the greater part of the year.

BRITISH RAINFALL, 1912.—The publication of the annual volumes of *British Rainfall* is always looked forward to not only by meteorologists but also by engineers and surveyors, and others who have any interest in rainfall statistics. The volume for last year, 1912, has recently been issued, and this includes the records of rainfall from more than five thousand observers in Great Britain and Ireland. The records confirm the popular opinion that the year 1912 was a very wet one, as will be seen from Table 71.

The greatest amounts of rainfall recorded in the year were 205·17 inches at Crib Goch, on Snowdon, and 196·43 inches at the Stye in Cumberland. The lowest amount was 19·24 inches at Stifford, in Essex. It appears that the summer of 1912 in England and Wales was wetter than any other summer during the past fifty years, although the rainfall of the summer of 1879 was nearly similar.

April, May, and September were the generally dry months, and March, June, August, and December the wet months.

TABLE 71.

	Rainfall for 1912.	Difference from Average.
England ...	39·31 in.	+ 7·25 in. or 23 per cent.
Wales	56·19 „	+ 9·01 „ „ 19 „ „
Isle of Man ...	41·85 „	+ 0·22 „ „ 1 „ „
Scotland ...	41·77 „	+ 4·70 „ „ 11 „ „
Ireland	44·06 „	+ 3·43 „ „ 8 „ „

The most remarkable feature of the year was the unprecedented rainstorm of August 25th–26th, in East Anglia, when more than six inches fell over an area of four hundred and forty-six square miles, and more than seven inches over an area of two hundred and forty-one square miles, while more than eight inches fell between Norwich and Brundall. Serious floods resulted from this extraordinary rainfall: the flood at Norwich was fifteen inches higher than the previous highest one in 1614.

Dr. H. R. Mill, the director of the British Rainfall Organisation, has been obliged, acting under medical advice, to take a long and complete rest. We trust that this cessation from work will restore him to health. During his absence the work of the organisation will be carried on under the joint direction of Mr. R. C. Mossman and Mr. C. Salter.

AEROPLANES AND WEATHER.—The recent attempt of Mr. Hawker to win the *Daily Mail* prize of £5,000 in the waterplane race round Great Britain reminds me of a letter I received a year ago from a correspondent, who attributed all the bad weather to the action of aeroplanes. The letter was as follows:

"Sir,—Has it not occurred to you and others that the bad weather, and consequent likelihood of famine for us all, is due to this interference with Nature's laws? This foolish so-called 'flying' is cutting up the atmosphere. It is well known that heavy firing of guns brings down rain by concussion, and it stands to reason that great steel propellers, slashing the air for great distances, is bound to cause violent disturbance of the weather. Wherever there is 'flying,' there come storms of wind and torrents of rain, and bitter cold as by an electric fan. So do stop this rubbish lest we all starve."

The writer of the above evidently has a very decided prejudice and hatred against flying machines, and also is ready to attribute good or bad weather to unknown influences. One often hears many other people give expression to somewhat similar opinions as to the weather, although it is very doubtful if they really *think* anything about the matter. A few years ago very decided opinions were expressed by many people who asserted that the wireless installations erected at certain places round the coast had quite altered our weather. Up to the present, however, the ordinary meteorological observations have not shown that any perceptible effect has been produced by these things on the weather.

The cheap newspaper press is also much given to the use of terms and adjectives about passing events—even about the weather—which are great exaggerations and often incomprehensible. Anything that in the slightest degree interferes with pleasure, sport, or comfort is at once described in terms of execration. As an instance of this the following example may be given. Thursday, August 28th, was very fine and bright, but the next day, Friday, was misty, damp, and close, with a slight thunderstorm and little rain between 10 and 11 a.m. On Saturday morning a placard of one of the London daily papers was wholly taken up in large type with the words "Grumpiest Day of the Year." It is difficult to understand what the editor meant by such an expression. He could hardly have realised that a few hundredths of an inch of rain are quite insignificant compared to the eight inches which fell in Norfolk only twelve months previously, as mentioned in the preceding note.

XUM

MICROSCOPY.

By F.R.M.S.

AN IMPROVEMENT IN THE HAND MAGNIFIER.—Mr. W. G. Williams, of the Swansea Field Naturalists' Society, has sent a sketch of a very simple way of using a magnifier so as to have one hand free. Usually the magnifier is held in one hand, and the specimen in the other, and if it is desired to arrange the specimen or refer to a book, the magnifier has to be set down, and the observation begun again. It will be seen by reference to the drawing that hole A (see Figure 397) is made of sufficient size for the frame of the magnifier to rest on the top of the third finger of the left hand. the specimen under examination is held between the thumb and first finger, and the right hand is free to do dissecting or for other purposes (see Figure 398). The improvement costs nothing.

FIGURE 397.

TERMITES.—A short time ago a friend living in the Orange Free State sent me some specimens of the Termites (usually miscalled White Ants) found in that district, which are apparently quite as mischievous to woodwork there as their relatives in India and elsewhere, and in general appearance they do not greatly differ.

FIGURE 398.

The Royal Cell containing the Queen was dug up from about four and a half feet below the surface of the ground; it was oven-shaped and measured five inches in length by two and a quarter inches in width, with a height in the centre of one inch. It was perforated by numerous small holes giving access to the workers and soldiers, but, of course, useless as a means of exit for the Queen, whose distended abdomen measured three inches in length and was three quarters of an inch in diameter at its widest part. The workers measured ·175 inches, were pale yellow in colour and without eyes, for which they had no need, since they carry on their operations in darkness, their home duties being mainly to feed the Queen and to remove the eggs as laid. Each bore a pair of moniliform antennae of fifteen joints, and in addition to the usual mouth organs was armed with a pair of strong mandibles eminently adapted for the destruction of wood. The soldiers were considerably larger in size, measuring ·3 inches, of which the head alone was rather more than one third; they were dark red in colour and in addition to antennae resembling those of the workers, were furnished with a pair of formidable mandibles worked by muscles of great power. On carefully comparing these mandibles with available figures, and particularly with those of *Termes bellicosus* at the Natural History Museum, I found that they differed materially in shape, and regarding this as indicating a different species I did my best to identify it. In this, however, the Museum experts were unable to help me, and a reference to the learned Professor who is regarded as the greatest European authority on the subject only resulted in his opinion that though it appeared to be a new species he would not definitely commit himself on the matter from the drawings and specimens submitted. I therefore give drawings of the mandibles of these soldiers (see Figure 399) and also of those of the nearest form met with, *T. bellicosus* (see Figure 400), thinking that the comparison may be of interest to some of our readers.

R. T. L.

FIGURE 399.
Mandibles of a Soldier Termite.

FIGURE 400.
Mandibles of *Termes bellicosus*.

NEW METHOD OF RADIO-MICROGRAPHY BY P. GOBY.—A new and very attractive branch of science has lately been opened up owing to the researches of a French savant, and workers in various fields will now have a new resource at their disposal, this being known as radio-micrography, as it is the application of the well-known principles of radiography by the use of the X-rays to microscopic research. While there has been a great improvement made in the methods and instruments used for radiography of large specimens of ordinary size, and remarkable results in the way of radiographs are now obtained with such apparatus, we are not aware that the structure of microscopic specimens has been as yet revealed, so that the apparatus invented by M. Pierre Goby, of Grasse, and the radiographs which he secures by the use of the rays, will be of interest to all naturalists. By observing the views of the different specimens which we present in Figures 401–405 on page 389, it will be seen at once that the method is likely to be a valuable auxiliary in all kinds of research work, and the interior structure of the specimens can in most cases be shown up very clearly, as, for instance, in the case of microscopic shells, diatoms, and the like. Not only can the method be used for what may be termed strictly microscopic specimens, but it can also serve for enlarged radiographs of very small animal specimens, where an ordinary radiograph would be too small to give the required details.

In the account of his new method, which M. Goby has kindly given to us, he states that in both these cases the results are obtained by the use of a special X-ray apparatus of his design, and he expects to make public the details of the device at a not very distant date. Meanwhile he has given us some radio-micrographs, as they must no doubt be called, and they speak for themselves. The details which he thus obtains are difficult and in a great number of cases impossible to obtain with the usual method of sections prepared for microscopic use. From the start, he commenced to apply his researches in the field of palaeontology as well as in conchology, and finds that the protozoa in general, as well as foraminifera of all species and other analagous microscopic specimens, can be observed in their most minute details in the interior of their structure, and to show what can be done by the new method we may state that he was able to detect the presence of different species in cases where ordinary examination would lead one to suppose that only one species was present. In all the sands which contain microscopic specimens of different kinds such as have not been examined, the use of a fine pinch of sand allows of discovering new species and to make a very exact determination of their nature. The specimens which are illustrated here (see Figures 401 to 405) are magnified from twenty to twenty-five diameters. One of them shows a pinch of sand from the south of France (see Figure 404), containing a number of different forms.

Not less interesting is the application of the radiographic method to very small animal specimens, and this allows us to observe the gradual formation of the bones from the birth of the animal to its full age. Not only can the details of the bone structure be followed very clearly, but the method allows of noticing the special features of the skin in many cases and different anomalies—this with great precision in the details.

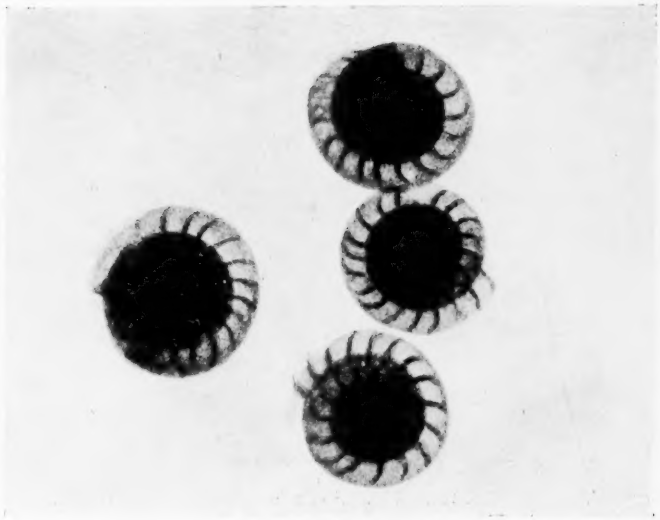


FIGURE 401. Nummulites.
Magnified 25 diameters.

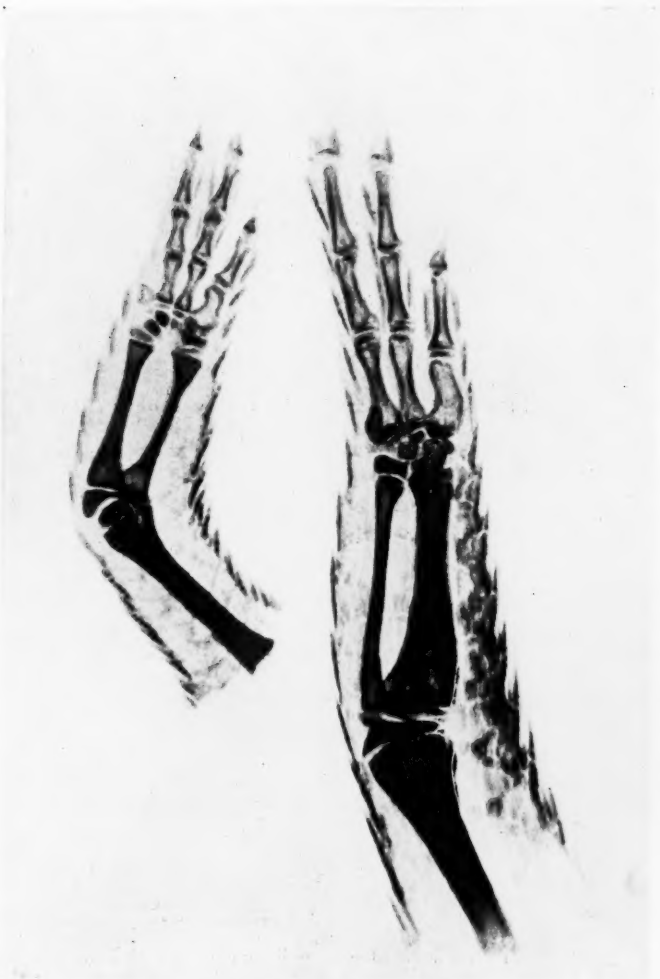


FIGURE 402. Fore and hind limbs of *Seps*.

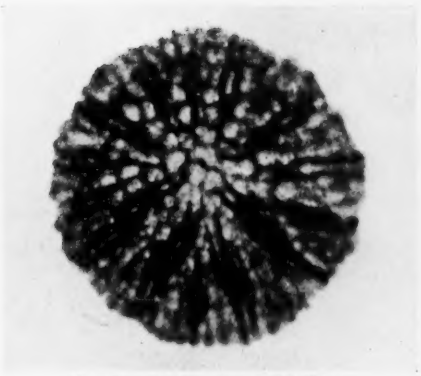


FIGURE 403. An Orbitolite.
Magnified 25 diameters.

FIGURE 404. A pinch of sand from the South of France. Magnified 20 diameters.

FIGURE 405. *Seps tridactylus*.

XUM

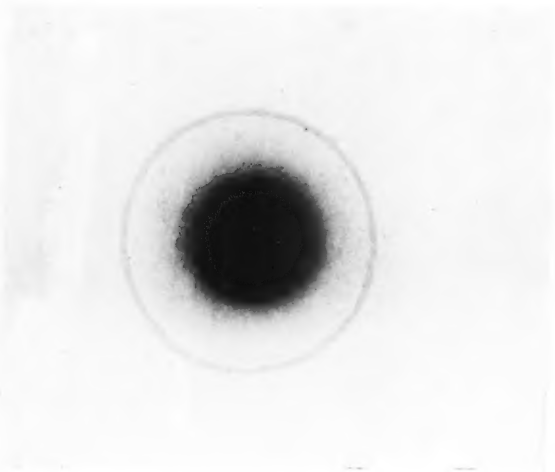


FIGURE 406. Halo obtained with X-rays without crystal.

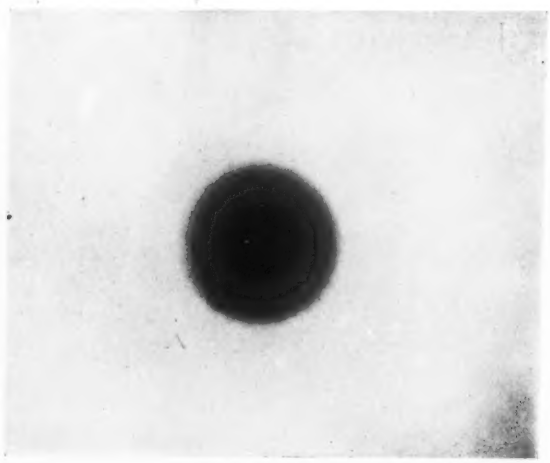


FIGURE 407. Halo from metals without crystals.

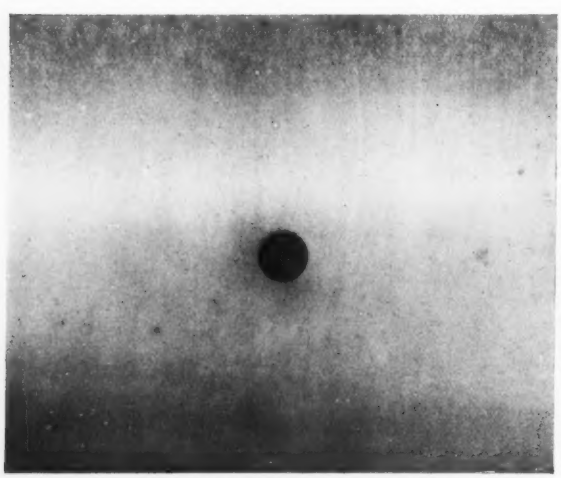


FIGURE 408. No crystal used. Showing a broad white band across plate; also black bands.

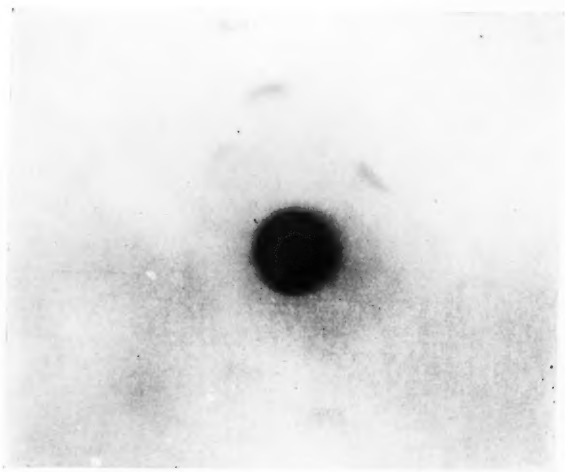


FIGURE 409. Spots from mica normal to rays.

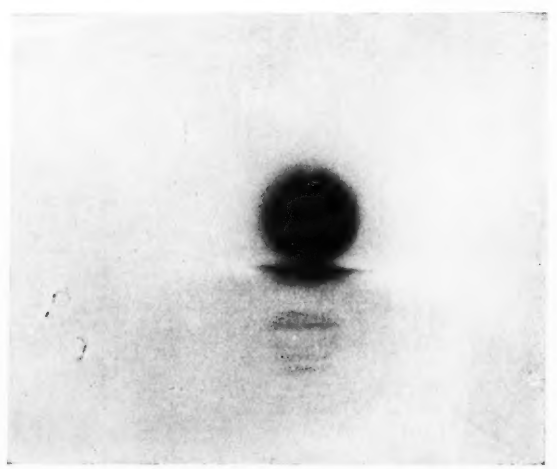


FIGURE 410. Reflection from mica at angle 85° showing bands on the reflection and intermediate band.

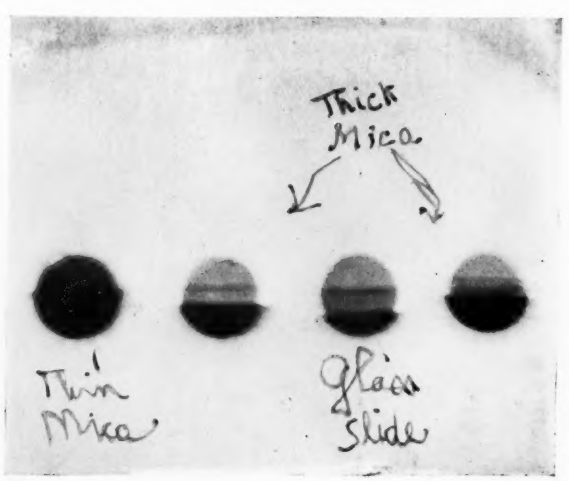


FIGURE 411. Shows peripheral effects with mica across aperture in metal screen.

As will be observed in some of the illustrations, the flesh parts and even the details of the muscles are apparent and are clearly represented. It would be too long to enumerate the applications which the new field of radio-micrography is likely to obtain in the near future, but in furnishing the present radiographs M. Goby is confident that scientific men will find it valuable for different kinds of research work, and no doubt it will be taken up in various quarters.

FRANCIS P. MANN.

Since the above was received M. Goby has described his apparatus, and the following description is taken from a translation of the contribution to *Comptes Rendus*, CLVI., pages 686–688, which appears in the current number of *The Journal of the Royal Microscopical Society*, from which we have copied the diagrams shown in Figures 412 and 413.

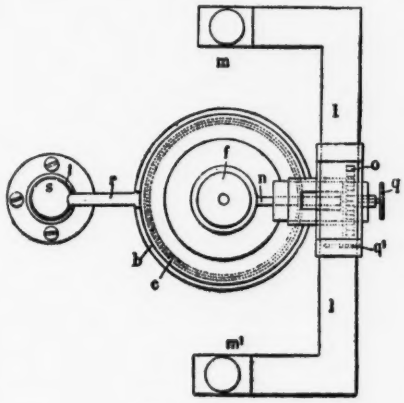


FIGURE 412.

The difficulty of obtaining by the Röntgen rays the requisite clearness of detail has been overcome by means of the apparatus shown in Figure 413, which is carried on the telescopic pillar *u v*, the movable joint *s* of which allows it to be pivoted in a horizontal position.

Two large metal cylinders a^1, a^2, the one sliding within the other, form a photographic camera body, the length of which can be varied as wanted. The top of this body *c* is provided with a socket c^1 through which slides the axial metal tube *d*, which is destined for suppression of the secondary or superfluous rays, and for the transmission of the cluster of active rays, which the thick leaden diaphragm *f* of very small diameter allows to pass, whilst a disc *g* opaque to the luminous rays alone, shuts off other light which might affect the photographic plate.

At the other extremity of the tube *d* an "incidence indicator" or device for enabling the incidence of the rays to be regulated is adapted, which consists essentially of a very narrow metallic tube *i*, supported by two discs h^1, h^2, permeable to the X-rays. Normally to this is placed a small fluorescent screen *j*, which can be examined through a darkened glass disc *k*, destined to protect the eye of the operator, when the apparatus is put in a horizontal position. By means of the mechanism *o*, *p*, *q*, the focus tube carrier *l* can be adjusted in two directions, and all that is necessary is to adjust the special Röntgen tubes held by the isolating clamps *m*, m^1, so that the small luminous spot is seen in the centre of the screen surrounded by a dark circle, thus indicating that the central ray of the cluster is following a path axial to the tube itself. One can now regulate the desired sizes of the radiographic field indicated by the extent of the illuminated zone of the screen, by sliding the tube *d* nearer or farther away from the source of radiation. After once centring the focus-tube by means of the incidence indicator, this does not need to be repeated, the indicator being then slipped out of the tube *d* and laid aside.

All that now has to be done is, in the light of an ordinary dark room, to place a small photographic plate, square by preference and of very fine grain, on the centre of the leaden disc *b*, which forms the base of the camera, and which is marked with a diametrical cross for purposes of registration. The small object to be radiographed is placed in direct contact with the sensitised surface of the plate without the interposition of black paper. It only remains to pull down the cylindrical camera body into its grove and to allow the appropriate rays of a Röntgen tube, with a very small anticathode, to act for a convenient time in order to obtain, thanks to the normality of the incident rays and to the suppression of the paper envelope, the great clearness of detail which allows of the radio-micrographs being enlarged to a considerable size.

PHOTOGRAPHY.

By EDGAR SENIOR.

FAULTY PERSPECTIVE SEEN IN MANY PHOTOGRAPHS.—Anyone who has compared a photograph with the scene that it was intended to represent must have noticed on many occasions the great amount of difference existing between the two with regard to the relative size of the objects depicted when the photograph has been taken with a short-focus lens. We have an example before us as we write, taken with a lens of this kind, in which the size of the objects in the foreground is out of all proportion to those at a distance, and this is by no means an isolated example, but is quite a common effect obtained by the use of wide-angle or short-focus lenses; and although wide-angle lenses are useful at times, such as when working in confined situations, there is the attendant disadvantage that objects situated in the foreground are made to appear too large compared with those at a distance. In considering the cause of this phenomenon, we must remember that the eye when looking steadily at an object forms an image upon the retina which embraces an angle of not more than 60°; therefore, in order that a photograph may convey a correct idea of the relative size of the objects represented when it is viewed at a distance of ten or twelve inches, the angle included in the picture should not be greater than that of the angle it subtends for vision, which is from 55° to 60°; since if more is included in the photograph than this, the images of objects in the foreground will appear too large in comparison with those at a distance. To render it obvious that distortion of this nature is not really due to any fault of the lens, it is only necessary to view the photograph at a distance equal to the focus of the lens with which it was taken for the distortion to disappear, or, better still, to enlarge the picture, as then it would be viewed at a correspondingly greater distance. The conditions under which a photograph will give a true representation of natural objects have received considerable attention from Dr. Alexander Gleichen, and in a paper translated by Dr. Lindsay Johnson, M.A., F.R.P.S., and published in *The Photographic Journal*, the author appears to consider that the aperture of the lens should not in any case be larger in diameter than the pupil of the eye (about eight millimetres), and that the focus of the lens employed should not be less than ten inches (the normal distance of distinct vision), or if the focus is less than this the picture must be afterwards enlarged as many times as the focus is less. Now, in using a ten-inch

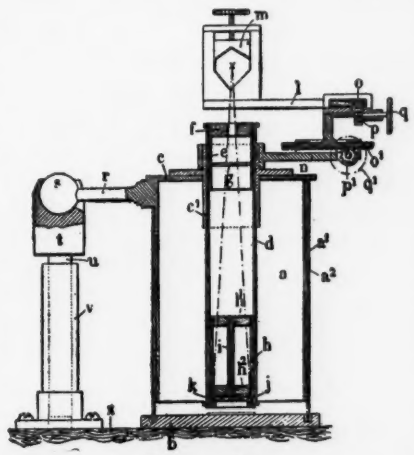


FIGURE 413.

focus ens with an aperture of eight millimetres ($\frac{5}{16}$) in diameter, it is evident that the rapidity of the lens would be equal to F/32, and this would be far too small for many purposes. But as the size of the aperture is limited to $\frac{5}{16}$ of an inch in diameter, the only alternative is to use a shorter focus lens, and so gain rapidity in that manner. Suppose, then, that we wish to obtain a rapidity equal to an aperture of F/6·4; then as the rapidity of lenses varies inversely as the square of their focal lengths and the square of the diameter of their apertures, the desired end would be gained by reducing the focal length of the lens in the same proportion as the diameter of the aperture would otherwise have to be increased, which in this case is five times; therefore, instead of using a ten-inch focus lens, one of two-inch focus would have to be employed; and as $2 \div \frac{5}{16} = 6{\cdot}4$ we should gain the rapidity while the size of the aperture itself remained unaltered. At the same time the photograph would require to be subsequently enlarged five times in order to be seen in correct perspective when viewed at a distance of ten inches. If the degree of enlargement to be finally obtained has been previously decided upon, then the focal length of the lens necessary for use in taking the original photograph "in order that the required conditions may be fulfilled" can be found from the following equation:

$$F = \frac{v}{m}$$

where F = the focal length of lens required, v = the distance of distinct vision (ten inches), and m = the number of times the picture is to be afterwards enlarged. Thus suppose that the photograph is to be enlarged twice; then

$$F = \frac{10}{2} = 5 \text{ inches},$$

and as the diameter of the aperture is to be $\frac{5}{16}$-inch then $5 \div \frac{5}{16} = 16$, and the intensity ratio would be F/16. By transposing the above equation we are also able to obtain the distance from which the enlargement should be viewed.

$$v = F\ (m).$$

Thus suppose that a picture taken with the five-inch focus lens is subsequently enlarged twelve times; then $v = 5\ (12) = 60$ inches, and the enlargement when viewed from a distance of five feet should appear true to nature.

A SIMPLE FORM OF LENS SHADE.—It is obvious that any light which reaches the plate, apart from that which is actually employed in the formation of the image, must of necessity have an adverse effect upon it; and it is often found when using a lens larger than is necessary to cover the plate that the extra light which enters the camera, not being entirely absorbed by the dead black with which its interior is coated, causes a certain amount of haze or mistiness to appear over the entire image, which destroys somewhat the brilliancy of the picture. An effect of this kind is particularly noticeable when working in an unusually bright light, such as that obtained by the seashore, when something that will reduce this excess of light becomes desirable. Adjustable hoods have been recommended for attaching to the lens, but these are difficult to manage, and whatever is employed, if it act in such a manner that it only allows the lens just to illuminate the plate that is in use, then the rising front is rendered useless, as it is necessary for the circle of illumination to be considerably larger than that required to include the plate to enable this adjunct to a camera to be employed at all. The writer some years ago made some experiments in bright light by the seashore, to determine as far as possible the value of lens shades, using a stand camera so that the various effects could be studied visually as well as photographically, and the improvement that resulted in both cases when a thin piece of wood made to extend some four or five inches beyond the lens, and jointed so that it could be depressed to any extent short of intercepting the rays of light, was at once apparent. A shade of this description was made that could be detached instantly from the camera when not required, and as it folded up it was easily carried in the pocket. Such an arrangement, however, appears to be simply a modification of one used many years ago by the late Mr. William England, and which is described as a double-hinged mahogany flap which could be bent down over the lens; and from the very fact that it was found valuable by this gentleman in taking the very fine photographs which he produced should be an extra recommendation in its favour. Then in the case of telephotography a shade in the form of a hood becomes an absolute necessity for obtaining brilliant pictures, since the amount of light which is actually employed in the formation of the image is small compared with that which enters the positive lens; hence light traps in the form of diaphragms inside the lens tube and special care in the selection of a dead black and other devices are found inadequate when dealing with an amount of stray light which is many times greater than that used in taking the photograph. On this account a tube or hood attached to the front of the lens, and adjustable in length so that it can be altered to suit various angles or magnifications, as suggested by Captain Owen Wheeler, F.R.P.S., must be employed in cases of high magnification in order to obtain the most brilliant images.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

NEST MADE BY ORANG UTAN.—A recent issue (Part I, 1913) of *The Proceedings of the Zoölogical Society of London*, contains an interesting photograph, by Mr. Seth-Smith, of the nest made in a tree near the Apes' House by the large Sumatran Orang-Utan (*Simia satyrus*) which escaped from its cage in November, 1912. It may be recalled that a careful description has been given by Moebius of the nests which the Orang makes in the woods. A nest is made every night or every second night. It may be a yard and a half long by four-fifths of a yard broad. It consists of two dozen or so branches, with loose leaves above them. It is simply a temporary bed and not, as some have asserted, either a hut or a nursery.

A REMARKABLE FISH.—Messrs. Holt and Byrne have described from the south-west coast of Ireland a new deep-water fish (*Lamprotoxus flagellibarba*) with several remarkable features. The only specimen obtained had a body about seven inches long, without including caudal fin and lower jaw. It bore a filamentous barbel many times longer than the body. The colour of the scaleless skin was velvety black, and the barbel was grey. A purplish-grey cord-like band of luminous tissue, partially embedded in the skin, formed a closed loop on the anterior part of each side of the body. There was also a large photophore behind and slightly below the eye, occluded by skin save for a narrow slit. Very small photophores, hardly visible externally, were present in lateral and marginal series.

HERMAPHRODITE BEES.—In a hive in the Caucasus, G. Kojewnikov found hermaphrodite bees. There were also normal workers and drones from the same queen-mother. The hermaphrodites looked like workers with the heads of drones, but there was an intimate mixture of characters. One of the mandibles was a drone's, the other a worker's; the eyes were drone's eyes, the thorax was a worker's thorax. The sting was very variable. An interesting point is that while some of the hermaphrodites had an ovary on one side and a testis on the other, others had two ovaries or two testes. Yet those which were unequivocally females or males as regards the essential organs of generation were, nevertheless, hermaphrodites in skeletal parts. This seems to show that in this case the nature of the reproductive organs does not influence the development of the external sex characters.

COMMENSALISM OF ANTS AND CATERPILLARS.—Towards a hundred cases are known of caterpillars (Lycaenidae and Erycinidae) living in commensalism with ants. M. Charles Oberthür has recently called attention to two species in Brittany—*Lycaena argiades* and *L. baton*—which appear to illustrate this kind of association. Harold

Powell reports the same in regard to *L. baetica*, *L. bellargus* and *L. iolas*. An ant removed from its companion caterpillar (*L. baetica*) is restless and disturbed. In the case of *L. bellargus* the ant rides on the caterpillar and caresses it. Oberthür also refers to an Australian form which lives in the nests of green ants. When the imago hatches out it is covered with very deciduous white scales which fall like a shower of confetti when it takes to wing from among its quondam companions. There seems no doubt that this association of ants and caterpillars will reward further investigation.

LAND CRAYFISHES OF AUSTRALIA.—Very little is known of the habits of these interesting animals (species of *Engaeus*) which have left the aquatic habitat of their race and become burrowers in damp ground. The burrows are sometimes near the bank of a stream, but very frequently far removed from any water in the middle of the forest in some damp situation. There is water at the bottom of the burrow. Messrs. G. W. Smith and E. H. J. Schuster, in a recent study of the species of *Engaeus*, call attention to the great depth of the carapace, its arched roof-like shape, the reduced abdomen, the small eyes, and the tendency to reduction in the size of the gills. An unusually strong hairiness of the mouth-parts and neighbouring regions is probably correlated with the necessity of filtering the water in the burrows, which is usually very muddy. There are not a few minor losses or suppressions, *e.g.*, the loss of a flagellum on the antennule and the reduction of the antennary scale, and the authors suggest that the underground burrowing habit which removes the crayfishes from active competition with other aquatic forms has permitted degenerative changes which have no special adaptive significance.

The young are brought into the world and tended by the female parent in the same way as in the ordinary crayfish, being carried about attached to the swimmerets. As the animals keep to their burrows during the day, very little is known as to their feeding habits. "It is probable that they are mainly carnivorous in diet, as the remains of earthworms, insect larvae, and probably land crustacea have been found in their stomachs. . . . . The evergreen beech forests in Western Tasmania support a very rich terrestrial fauna of land amphipods (*Talitrus*) which swarm under the fallen beech leaves and timber, and numerous myriopods and insect larvae occur as well, affording abundant food in exactly the situations which *Engaeus* chooses for its burrows."

SPECIFICITY.—We have repeatedly referred in these Notes to the existence of minute peculiarities of structure which distinguish species, sometimes more convincingly and reliably than do larger and more obvious features. A fish may be known by a single scale or a bird by a single feather; and the cells lining the windpipe of a horse are readily distinguished from those of the dog which barks at the horse's feet. All flesh is not the same flesh, and nothing is more specific than the blood. On a larger scale are peculiarities of structure which run through a series of related forms. A good example is furnished by Mr. Edwin S. Goodrich in his study of the structure of bone in fishes. Ganoid scales are of two kinds, which differ fundamentally in structure and mode of growth—Cosmoid and true Ganoid. The latter are again divisible into Palaeoniscoid and Lepidosteoid. The Lepidosteoid scale is easily distinguishable by the presence of a system of delicate tubules running through and at right angles to the bony layers. The same peculiar tubules occur in the skull plates and other dermal plates of all the recent and extinct Lepidosteoids and Amioids that have been examined, with a single possible exception (probably a primitive form). The minute peculiarity is quite distinctive. Mr. Goodrich has more recently discovered that the Lepidosteoid structure is exhibited not by the dermal bones only, but by the whole endoskeleton as well. "The skull-bones, the ribs, even the vertebral centra, are all provided with the characteristic tubules traversing the bony lamellae, just as in the scales. It follows that, from the examination of the minutest fragment of the skeleton of a living or extinct species of fish, we can decide whether or not it belongs to the Amioidei and Lepidosteoidei, or to some other group. The histological structure of the bone, may therefore be of the greatest practical value for the identification of fragmentary specimens. It may also prove of great importance in the interpretation of phylogeny." This is a fine instance of a minute detail of structure holding good as an index of relationship.

AFRICAN ELEMENT IN FRESHWATER FAUNA OF BRITISH INDIA.—At the Zoölogical Congress at Monaco Dr. Nelson Annandale directed attention to the affinity, more close in some cases than in others, which can be demonstrated between the freshwater fauna of India and that of Tropical Africa. In some instances this affinity also extends to South or Central America. The African element in the Indian fauna was also compared with what we know to exist in the fauna of the Jordan system. In the latter a large contingent of the fish-fauna is pure African, but many of the lower aquatic invertebrates resemble African forms much less closely than do the Indian representatives of the groups. An explanation may be found, on the one hand, in the more recent date of the geographical connection between what is now the valley of the Jordan and the river-systems of Africa; and, on the other hand, in the fact that existing conditions of climate and chemical composition of the water are more similar in Tropical Africa and India than they are in the former and Palestine.

GALL-PRODUCTION.—Every contribution to the study of galls is welcome; for while great progress has been made towards understanding them the uncertainties remain very conspicuous. How far does the mechanical irritation produced by the parasite count as a stimulus? Or is it wholly chemical? To what extent do bacteria and other fungi play a part in stimulation? How far is the gall that is formed in response to the stimulus a quite new sort of growth? How is it that the same plant may produce several different galls in response to the stimulus of not distantly related hosts? How far can it be held that the host derives benefit from the gall because it thus restricts the sphere of the parasite's operations? How far, on the other hand, is the plant playing into the hands of its parasite by forming the gall?

In a recent elaborate study of Canadian galls Mr. A. Cosens maintains that the gall-producing stimulus renders the protoplasm of the host more active and awakens in it dormant characteristics, but does not endow it with power to produce entirely new structures. The idea that the gall-producing stimulus must be applied directly to the cambium is not true in all cases, for any actively growing tissue will respond to the gall-stimulus. Moreover the effect of the stimulus is operative on tissue at a considerable distance from the centre of application. There is no doubt that ferments secreted by the gall-producer (Cynipidae) count for much. They may pre-digest food for the larval gall-insect and may indirectly stimulate cell-proliferation.

PERIWINKLES AND THE TIDE.—It has been noticed that periwinkles (*Littorina littorea*) shift their position on the rocks in correspondence with the tidal changes. It has even been maintained that this tendency to periodic movement is so engrained in the periwinkle's constitution that it takes place apart from any tides. Recent experiments by Haseman do not confirm the last statement. It seems, moreover, that the oscillatory movements in normal conditions are not exhibited by periwinkles on horizontal flat surfaces between tide-marks or when they are below the low-tide mark. What seems to remain secure is that periwinkles on the vertical surfaces of rocks between tide-marks exhibit up and down movements which correspond with the movements of the tides.

MORE ABOUT BLACK TERMITES.—Professor Bugnion has told us something more about *Eutermes monoceros*, the Black Termite of Ceylon. In their nocturnal excursions to the trees—some of which were fifteen to twenty yards distant—they usually managed to keep to the same paths. As they are blind, they must feel or smell their way. Minute black specks

XUM

probably excrementitious, are often to be seen marking the path. An interesting observation refers to a case where the path followed went up four posts and down the other side instead of keeping along the level ground!

At critical places, or when danger threatens, the soldiers form a double file guarding the march of the workers, and they all face outwards. From an ampulla in their head they squirt out viscous fluid in the face of offensive true ants like *Oecophylla*. The nocturnal expeditions have the object of collecting lichens, débris of leaves, and apparently some black material from the humus.

HABITS OF THE AGAMA.—Dr. W. A. Lamborn gives an interesting account of the habits of the common West African lizard, *Agama colonorum*. There seems to be a great disparity in the numbers of the sexes, and each male is attended by several females, sometimes six or seven, who behave with remarkable subservience towards their lord and master. "The male's responsibilities seem to be in excess of his capacities, so that the females are forced to resort to various artifices to secure their share of his attentions." The males are exceedingly combative, and the intrusion of one into another's preserves usually leads to a battle. "The tail is the offensive weapon, and to bring it into action the males take up a position parallel to each other, but head to tail. Each seeks to overcome the other, not by a number of strokes, but by a single well-directed blow." The female lays the eggs, in a cluster of three or four, in a burrow in the ground, and covers them with earth. The lizards are usually insectivorous, but will eat lettuce, tomatoes, and the like, in the dry season. Their voracity is remarkable. On one occasion Dr. Lamborn dropped no fewer than eighteen butterflies before a male Agama, and all were consumed in ten minutes.

IN VERY DEEP WATERS.—Professor Louis Roule has recently described a new abyssal fish, *Grimaldichthys profundissimus*, gen. et sp. nov., which was dredged by His Serene Highness the Prince of Monaco from a depth of 6,035 metres to the south-west of the Azores. One of the features of this new form is that all the rays of the pectoral fin are free and filamentous. The rather dangerous title *profundissimus* indicates that up to date the depth inhabited by this fish is greater than that recorded for any other.

HATCHING OF CROCODILES' EGGS.—Many years ago (1899) Dr. Voeltzkow noticed that unhatched crocodiles (*Crocodilus madagascariensis*) utter a cry from within the egg—a cry that can be heard even when the eggs are covered, as in nature, by one to two yards of sand. The sounds are produced with the mouth closed, as we produce hiccough sounds. Dr. Voeltzkow writes:—"This crying of the young can be induced by walking heavily past the receptacle containing the eggs (a box in the study), by knocking against it, by taking an egg in the hand and turning it; in fact, any shock causes the young one to lift up its voice in the egg. As the female visits the nest almost daily in order to convince herself of its orderly condition, her passage from the water to the nest and back shakes the ground and induces the production of sound by those young ones which are sufficiently developed. Thereupon the old one scrapes the sand out of the pit and presently the young emerge." Dr. W. A. Lamborn has recently made similar observations in regard to *Crocodilus niloticus* at Lagos. Croaking noises were heard from below a dry path, and when he dug down he found thirteen eggs, all chipped save a bad one, at a depth of about eighteen inches. All the young crocodiles hatched out within half an hour of being dug up.

SOLAR DISTURBANCES DURING AUGUST, 1913.

By FRANK C. DENNETT.

AUGUST has been marked by a continued absence of activity on the Solar disc. On two days only (11th and 28th) tiny spotlets or pores were visible, on eight others (10, 14, 16–19, 27 and 29) faculae were seen, and on the remaining twenty-one days the sun appeared free from disturbance, unless exception be taken to a greyish patch some thirty hours past the central meridian, in north latitude, seen on the 24th. The longtitude of the central meridian at noon on August 1st was 87° 10′.

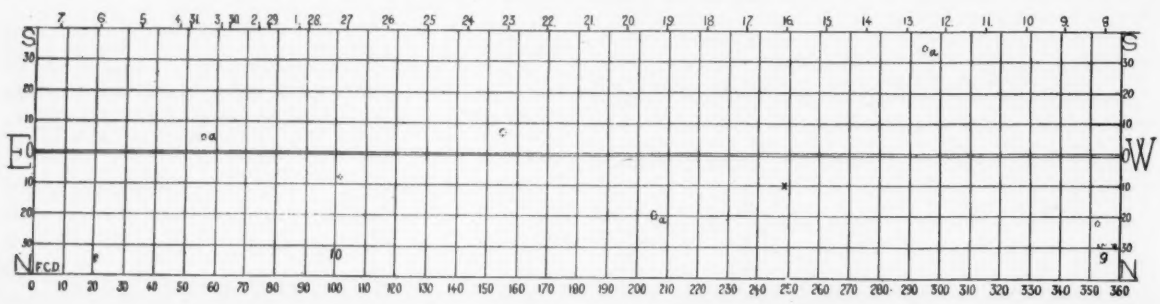
By some strange mishap the spot groups and faculae for July have not reproduced on the diagram in the September number of KNOWLEDGE; they have therefore been inserted in our present chart, the faculae being distinguished by the letter *a*.

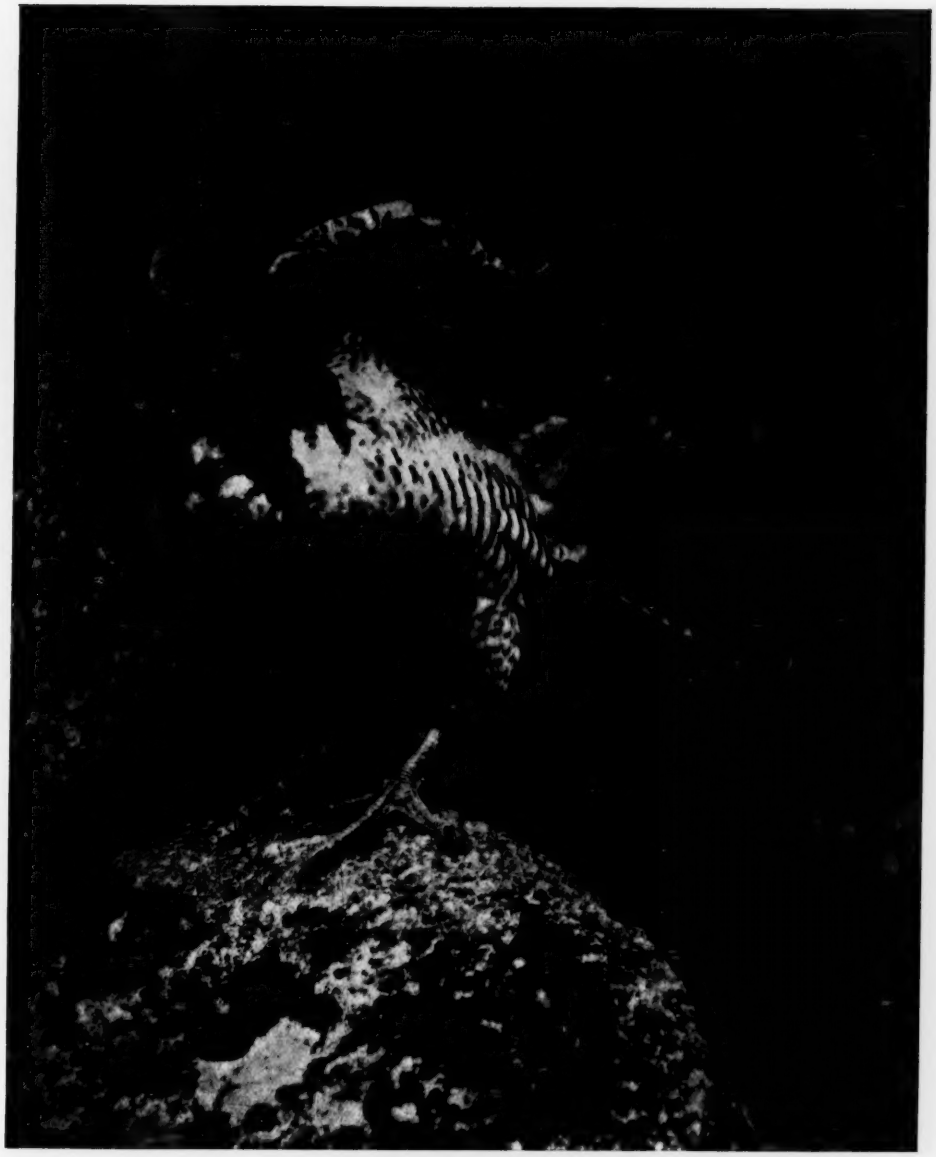
On August 11th a tiny pore was visible, amid faculae, advancing from the north-eastern limb; it was too minute for measurement, but was approximately in the position marked by a cross in longitude 248°, N. latitude 10°. Only seen on one day.

On the 28th a minute pore with faculae was seen some 40° round the eastern limb—approximately in longitude 40°—cloud intervened before exact measurements could be made. Faculae were visible on the 10th some 35° from the south-western limb. On the 14th a small double facula, situated just south of the area of Group No. 9, closing up to the western limb. On the 16th a small bright cloud seen less than 20° from the North Pole, some three days past the meridian. On the 17th and two following days a facula seen some 8° S. latitude, in longitude 155°. On the 27th a tiny facula was almost on the meridian about 18° from the South pole; also a brilliant knot in N. latitude 34°, longitude 21°; this remained visible on the two following days.

Our chart is constructed from the combined observations of Messrs. J. McHarg, E. E. Peacock, and F. C. Dennett.

DAY OF AUGUST, 1913.





By the courtesy of *Country Life, Ltd.*

FIGURE 414.

Male Peregrine Falcon or Tiercel.

(From "The Peregrine Falcon at the Eyrie.")

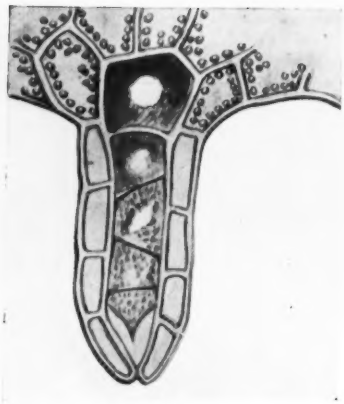


FIGURE 415.
An Archegonium of a fern.

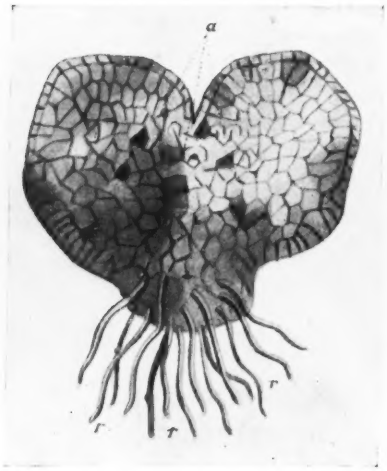


FIGURE 416.
A Prothallium of a fern.

FIGURE 417.
An Antheridium of a fern.

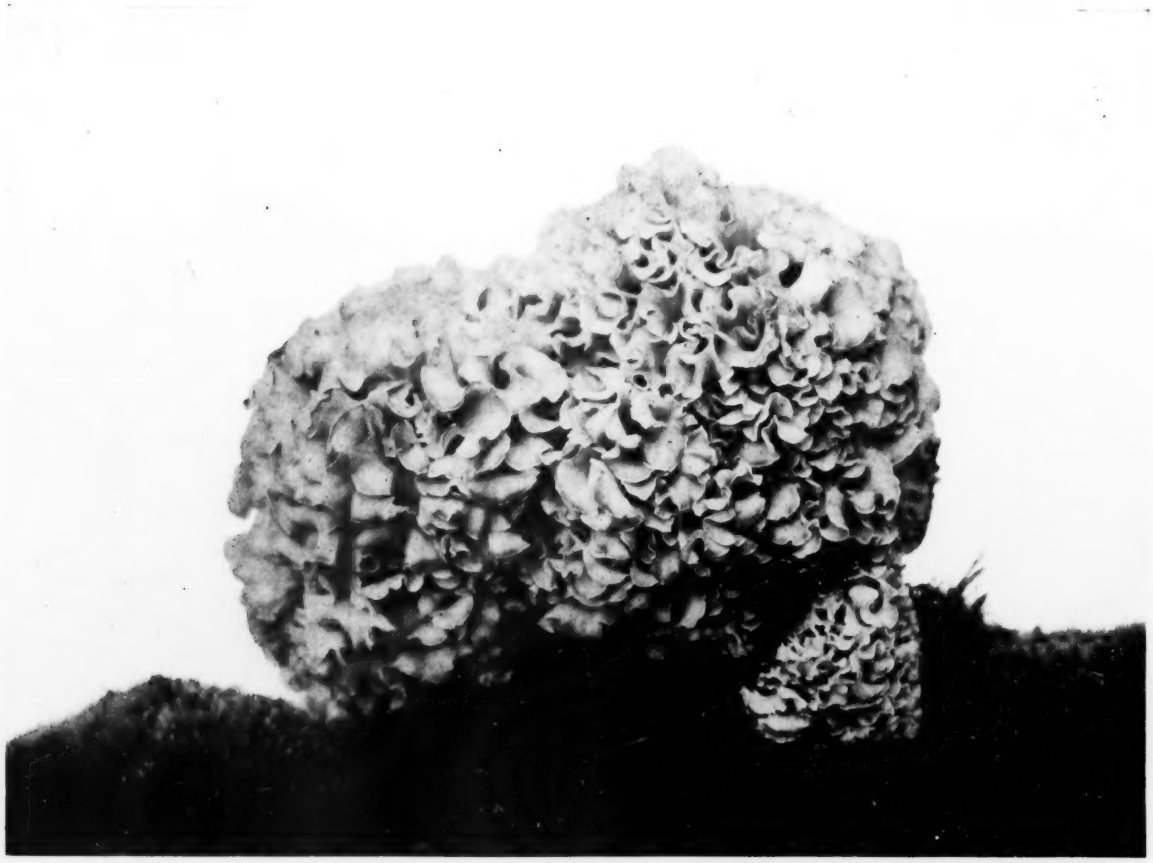


FIGURE 418. The Sparassis (*Sparassis crispa*).

A fungus (one-half natural size) covered with twisted, thin, brittle lobes of a creamy white tint, found only in pine-woods, and considered to be one of the most desirable of the esculent species.

(From "Hutchinson's Popular Botany," by the courtesy of Messrs. Hutchinson & Co.)

REVIEWS.

BIOLOGY.

La Biologie Synthétique.—By PROFESSOR STÉPHANE LEDUC. 217 pages. 118 figures. 9-in.×5¾-in.

(Paris: A. Poinat. Price 6 francs.)

This is a sequel to the author's *Théorie Physico-Chimique de la Vie et Générations Spontanées*, translated by Dr. Deane Butcher and published under the title of *The Mechanism of Life* (Rebman, 1911). Professor Leduc points out that hitherto life has only been studied analytically; that is to say, living organisms have been investigated by studying in detail each separate part. He suggests that it is time the synthetic method be applied in biology, since many of the phenomena associated with living organisms are exhibited (or, perhaps one would say, simulated) separately in the inorganic world. The book is highly suggestive, and the proposed synthetic method of dealing with biological problems ought to prove of great value. The book is marred, however, by a tendency to materialistic metaphysics—a domain which in reality lies outside of pure science. What Professor Leduc terms "physicisme" and "mysticisme" are complementary rather than antagonistic. Philosophy completes the work of science. The latter is concerned with the correlation of phenomena; the former seeks their source. The latter may adopt a mechanistic theory of life; the former must transcend this.

H. S. REDGROVE.

BOTANY.

Hutchinson's Popular Botany.—By A. E. KNIGHT and EDWARD STEP, F.L.S. Vols. I and II. 588 pages. 721 figures. 18 coloured plates. 10-in.×7-in.

(Hutchinson & Co. Price 7/6 each Vol. net.)

There was a time, and that not very long ago, when the study of Botany meant to a very large extent the mere collecting and naming of flowering plants. Hutchinson's "Popular Botany" shows well how things have changed. The inside of plants to many has become more interesting than specific differences. The way in which the various parts do their work and still more recently the interrelation between plants which form communities and the connection between plants and animals have attracted wide attention. All these topics as well as those groups of plants which do not bear flowers are considered and illustrated in "Popular Botany" by a wealth of photographs and careful drawings, the latter by Mr. A. E. Knight and the former, in many cases, by Mr. Edward Step. There are also eighteen coloured plates. The first volume contains chapters dealing with the cell, with tissues, with physiological processes, with structure, and lastly with the leaf in relation to environment. In the second volume the last-mentioned topic is completed, floral forms and their relations to insects are discussed at length, and the reproduction of flowering plants and lower forms is described and illustrated. Examples of the pictures, which are a great feature of the book, we are permitted to give on Page 396.

W. M. W.

CHEMISTRY.

Mineral and Aërated Waters.—By C. AINSWORTH MITCHELL. 227 pages. 114 illustrations. 8¾-in.×5½-in.

(Constable & Co. Price 8/6 net.)

From very early times the waters of certain springs and wells were supposed to have medicinal properties which were generally considered to be supernatural or miraculous. As the chemists of the eighteenth and early nineteenth centuries acquired a knowledge of the constituents to which the therapeutic effects were due, it was natural that attempts to prepare them artificially should be made. In this book the author gives a short account of spas, wells, and natural mineral waters, and then traces historically the development of aërated water manufacture from Bergmann's primitive efforts to the complicated methods of the present time. The latter involve not only the use of liquid carbon dioxide and elaborate machinery for aëration, but also ingenious mechanical methods of purification and bottling.

An excellent description of these processes, accompanied by many valuable diagrams and photographs, occupies a great part of the book. The chapter on the bacteriological and chemical examination of the manufactured products is interesting, but we think that, in view of the fact that the amount of lead in citric and tartaric acids has not reached the minimum suggested by analysts, some of the common tests for this metal might have been included. The work of Bardet has shown lately that though lead, tin and silver are generally constituents of well waters, they are only present in spectroscopic amounts, so that the acids and essences—which, by the way, are scarcely mentioned in the book—are probably the only sources of impurities. The bibliography might have included, with advantage, such works as Raspe's "Heilquellen Analysen" and the "Deutsches Bäderbuch."

These omissions however, do not detract from the merits of an excellent book, which is not only extremely interesting to the general reader, but should prove most useful to the manufacturer.

A. S. Jr.

Treatise on General and Industrial Organic Chemistry.—By Dr. E. Molinari. Translated from the Italian by T. H. Pope, B.Sc., F.I.C. 770 pages. 506 illustrations.

(J. & A. Churchill. Price 24/- net.)

This volume is practically a continuation of the author's work on Industrial Inorganic Chemistry which was recently reviewed in these columns, and deals with the subject upon similar lines. The first part gives a general outline of the physical and chemical methods of examining and identifying organic compounds, and includes sections upon elementary analysis, determination of molecular weights, and the relationship between physical properties and chemical constitution. Part II gives an account of methane and its derivatives, and includes hydrocarbons, fats, alcohols, and sugars; while Part III. deals with cyclic compounds, including aromatic hydrocarbons, phenols, colouring matters, proteins, glucosides and so on. In the case of each group of compounds, a general outline is given of the characteristics of the principal individuals, and this is followed by an account of industrial methods of preparing those of technical importance. For example, twenty pages are devoted to the description of the manufacture and purification of illuminating gas, and a similar space to petroleum and its products.

The author's aim appears to have been not so much to give exact details of experimental work as to enable the reader to follow the principles upon which the industrial processes are based.

Dealing with such a wide range of subjects, it was obviously impossible for one man to be thoroughly conversant with them all, and in certain places this want of first-hand knowledge is manifest. Taken as a whole, however, and judged by those sections with which the reviewer is most familiar, the book may be recommended as accurate and up-to-date. Here and there small errors and inaccuracies may be noted. For example, it is not correct to state that "in comparison with all other fats, butter contains a large quantity of volatile acids soluble in water." Possibly, however, it is the translation that is at fault here, and the reading should be "a larger quantity than any other fat." The slip on page 281 where it is stated that "the most favourable temperature is 30 per cent." makes the passage meaningless. If "30° C." is meant, the statement is not borne out by the facts.

The book is profusely illustrated, but it is to be regretted that worn electros have been used for many of the illustrations.

XUM

In the future edition, which is sure to be needed before long, it would be advisable to replace many of these blocks by fresh drawings. The work deserves it.

C. A. M.

GEOLOGY.

Volcanoes, their Structure and Significance.—By Professor T. G. Bonney, Sc.D., LL.D., F.R.S. Third Edition. 379 pages. 16 plates. 21 illustrations. 8½-in.×6-in.

(John Murray. Price 6/- net.)

Since the second edition of this work much has been added to our knowledge of vulcanicity by the great eruptions of the Soufrière and Mont Pelée, and by those in Guatemala and Savaii. The first-named, however, was treated in an appendix to the second edition, but in this book it assumes its proper place in the text as, in at least one feature, a new type of vulcanicity. The book is divided into six chapters, each elaborating one aspect of volcanoes, their life history, products, dissection, geological history in Britain, distribution, and origin. The book is written in a picturesque and vigorous style, well adapted to sustain the interest of the general reader for whom it is intended. A disarming preface wards off undue criticism. We may perhaps observe that while the simplified petrographical nomenclature adopted may be very comforting to both author and reader there is no such simplicity in the rocks themselves; and although the author animadverts on the great number of new names, the majority of them are absolutely necessary if any serious comparative work in petrology is to be done. Professor Bonney also favours the older view that there were two periods of eruption in the famous old volcano of Arthur's Seat, Edinburgh; but the recent detailed mapping of the Scottish Geological Survey is decisive in favour of Professor Judd's view that it is the product of one continuous volcanic episode. The book concludes with an admirable chapter on the various theories advanced to account for volcanoes, in which we should have liked to have seen some reference to Daly's recent fine work on the mechanism of volcanic action.

G. W. T.

Submerged Forests.—By Clement Reid, F.R.S. (Cambridge Manuals). 129 pages. 5 figures. 6½-in.×5-in.

(The Cambridge University Press. Price 1/-)

At many places around the English coast black peaty earth, with tree-stumps and other plant-remains, is exposed between tide-marks. Several layers of this material, the lowest generally at a depth of sixty feet below sea-level, are often found in dock excavations. These submerged forests, although, as explained by the author, muddy subjects to dabble in, are replete with scientific interest, and their exposition has given rise to a most interesting little volume. Submerged forests and their correlatives, raised beaches, give the clues to the most recent vicissitudes in the relative levels of land and sea. According to the author's estimate the submerged forests indicate a recent subsidence of nearly ninety feet of the land with respect to the sea. The newest of these deposits belongs to the age of polished stone, and the earliest also probably comes within the Neolithic period. In Mr. Reid's opinion the earth-movements ceased about three thousand five hundred years ago, and began about one thousand five hundred years earlier. These estimates, as we are carefully told, are not to be taken as exact, since they are based on somewhat uncertain factors.

Most of the book is occupied with the description of the submerged forests seen on the English coasts. Amongst the interesting subjects dealt with, the Dogger Bank, and the question as to the mode and date of the severance of Britain from the Continent, are the most likely to appeal to the general reader. The author is to be congratulated on this fine exposition of what, at first sight, appears to be an unpromising and difficult subject.

G. W. T.

HISTORY.

Ancient Greece.—By H. B. Cotterill, M.A. 498 pages. 12 plates. 4 maps. 141 illustrations. 8½-in.×5½-in.

(George Harrap & Co. Price 7/6 net.)

In an agreeable and compendious volume Mr. Cotterell has furnished a popular history of Ancient Greece from the earliest times about which anything is known down to the life of Alexander the Great. He has interwoven with it some account of Greek philosophy, literature, and art, and added copious illustrations of sculpture, vases, ancient sites, and famous men. The book will be a boon to the general reader, who, with no knowledge of the Greek language and no inclination for laborious study, would gladly acquaint himself with the meaning and the place in history of all that is most beautiful and expressive in art. The book, in fact, supplies a want that must often have been felt by intelligent people with small leisure. Mr. Cotterill sketches briefly the results of recent discoveries throwing light on Aegean civilisation, and shows how the early history of Greece was connected with that of Crete and Egypt; facts made additionally clear by a useful chronological table, which provides an approximate idea of their contemporary histories. In later times that most tragic and graphic chapter in Greek history, the Sicilian expedition, is illustrated by quotations from Thucydides; the march of the ten thousand from Xenophon. Mr. Cotterill writes with a keen appreciation of what he describes and the illustrations, to which allusion has already been made, have been judiciously selected and well reproduced. Even coins have received attention in this pleasant and useful book.

E. S. G.

PHYSIOLOGY.

Laws of Sexual Philosophy.—By J. L. Chundra. 208 pages. Frontispiece. 7¼-in.×5-in.

(Calcutta: The Author. Price 4/- net.)

Dr. Chundra is Professor of Medicine in the National College of Calcutta, and his book is designed for students of gynaecology and obstetrics. The volume contains much that is of physiological and medical interest. Among other points it discusses the theories which have been brought forward and the experimental investigations, for instance of Professor Schenck, with regard to the determination of sex. The chapter entitled "The Laws of Genius," in which the question of influence transmitted by parents to their children is discussed, will hardly at the present time obtain serious consideration.

W. M. W.

POLITICAL ECONOMY.

The Fate of Empires. Being an Inquiry into the Stability of Civilisation.—By Arthur John Hubbard, M.D. (Dunelm.) 220 pages. 3 figures. 8¾-in.×5¾-in.

(Longmans, Green & Co. Price 6/6 net.)

Dr. Hubbard has an interesting thesis to maintain. He attempts to discover those forces which make for the growth and decay of civilisation and of which history gives us only the resultant. Of the latter he holds there are two, namely, those due respectively from the social stress (*i.e.*, the competition of one's fellows) and the racial stress (*i.e.*, the trials and troubles of parenthood). Every stage in the history of organic advance, he argues, will be found to be governed by a new method or idea whereby life can be maintained on a high scale. Each new method is superimposed upon the old, which is utilised, not discarded, by the new. These methods are as follows:—(1) Reflex Action; (2) Instinct; (3) Reason; (4) Religious motive. Instinct sacrifices the individual to the race; Reason, which results in Socialism, Dr. Hubbard maintains, sacrifices the race to society, whose interests under such a régime are identical with those of the individual. In support of this he contends that Socialism appears simultaneously with a fall in the birth-rate. The method of religious motive, he contends, alone reconciles the interests of individual, society, and race by raising conduct from geocentric to cosmocentric significance.

XUM

I am inclined to think that Dr. Hubbard has fallen into the error of identifying reason with selfishness. Pure reason is motiveless; it is an organon which any desire may utilise to gain its ends; and for this reason Dr. Hubbard's enumeration of the methods of organic progress seems hardly satisfactory. Nor is there any reason why Socialism should result in a falling birth-rate; the instinct to propagate one's species (to look at the question from a purely selfish standpoint) is, on the whole, sufficiently strong to counteract the desire for ease and comfort; and whilst one can thoroughly agree with Dr. Hubbard's appreciation of the method of religious motive it is difficult to see how any system of political economy could be constructed on this basis. The State can compel its members to obey laws constructed by the aid of reason for their own benefit; it cannot compel them to be religious, though much can be done by means of education. The theoretical portion of Dr. Hubbard's book is followed by an historical section in which his views are illustrated by reference mainly to the Roman and Chinese civilisations. The account of the latter is particularly interesting and suggestive.

H. S. REDGROVE.

SPORT.

The Tarn—the Lake.—By C. J. HOLMES. 48 pages. 8½-in. × 5½-in.

(Philip Lee Warner. Price 2/6 net.)

"The Tarn—the Lake" appears to be a prettily written and imaginative treatise on fishing, but after the first two chapters Mr. Holmes switches the giddy and bewildered reader on to the Italian Renaissance, and proceeds to discourse on "Shoes and Ships and Sealing-wax." Not that his observations on these and kindred subjects are wholly lacking in suggestiveness, but it is such a far cry from reminiscences of his youthful experiences with minnows, and he takes so much for granted, and he asks so many questions and never waits for an answer. But eventually he deduces to his own satisfaction the conclusion that degeneracy overtakes men and fish alike, when all the natural incentives to healthy exertion are too carefully removed.

E. S. G.

ZOÖLOGY.

An Introduction to Zoölogy.—By Rosalie Lulham, B.Sc. 457 pages. 6 plates. 328 figures. 7½-in. × 5-in.

(Macmillan & Co. Price 7/6.)

Miss Lulham has such a reputation in connection with Nature Study work that one would expect any book that she might write to be interesting and original. We are not disappointed with the present volume, and it is evident that much of the information included is culled from the writer's own observations. If the classifications given are not always those which have been based on recent researches it may be that the author has in mind those who wish to classify things more particularly in the field. For instance, the dragon flies with no complete metamorphoses are still placed in the order Neuroptera with such forms as the lace-wing fly, where there is a resting stage. The reason suggested can, however, hardly explain why the Testacellidae, which contains the worm-eating slugs, the most highly modified of all land mollusca, is not put at the head of the Stylommatophora, and from the description also it is not evident that forms with well-developed shells are placed in the family. Any little points of this kind are, however, over and again made up for by the practical notes given at the end of each chapter, and we may mention specially those on ants and the keeping of ants' nests. There are also many useful hints and references given of the greatest value to young students. In fact, the book is intended to take the place of ordinary notes for those whose teachers spend most of the time at their disposal, as should be done, in practical work.

W. M. W.

The Peregrine Falcon at the Eyrie.—By FRANCIS HEATHERLEY, F.R.C.S. 78 pages. 30 illustrations. 11-in. by 8-in.

("Country Life." Price 5/- net.)

Mr. Francis Heatherley is a bird-lover with a knowledge of photography who during three seasons has carefully watched the eyrie of the peregrine falcon, and the book under consideration contains the records of his own and his friends' observations. The author says that what little experience he has had of the official ornithologist makes him anxious not to be confounded with the latter, as the present mania for bird and egg collecting is deplorable, considering the difficulties it places in the way of study when so much remains to be learnt of the habits of living birds. Mr. Heatherley has also no exaggerated veneration for the printed word which he too often finds is copied from one text-book to another in default of original observations, and in the case of the peregrines, his only working hypothesis was that the falcon is bigger than the tiercel.

Among the chief points of interest brought out are the time of incubation and the way in which, after a few days, the falcon handed over to her mate the actual work of feeding the young and looking after them while she spent her time in hunting and bringing the quarry to him. On one occasion the hen bird absented herself for a considerable time, and Mr. Heatherley is doubtful whether she did this voluntarily, owing to the constant presence of strangers, or whether she had been shot, and the tiercel managed to secure the services of another falcon. It would be interesting to know whether, if he had been left to himself, the male bird would in the end have been driven to hunt to appease his hunger, and that he would afterwards have fed the young. It appears that the prey that was brought to the nest for the latter was plucked or not according to the time which the falcon had at her disposal. What she brought for the tiercel's own consumption was usually skinned. The young ones paid more attention to the warning note of their father than that of their mother, and it is curious that when they began to take their food with less alacrity the tiercel encouraged them by giving a sharp yap.

Mr. Heatherley has come to the conclusion that the difference in size between the nestlings is a sexual one, and not dependent upon the fact that incubation starts with the first laid egg. Mr. C. J. King, who visited the eyrie in 1913, found that of the three eggs one was larger than the others and weighed fifty-eight grains more, while the difference between the two small eggs was not more than a grain. Of the peregrine language the author only learnt three phrases, but he says that the use of a hiding contrivance greatly enlarges one's appreciation of bird language—a rich field for investigation. "In raising himself from the wild, man has cut himself off from much knowledge of the ways of his poor relations, knowledge some of which even our immediate ancestors retained; for instance, the use of the great grey shike as sentinel by the Dutch trappers of passage hawks, a use of a bird's characteristic implying an intimate knowledge few museum authorities would care to claim. Modern bird-photography and nature study are, however, again lifting the veil."

In concluding his very original and interesting book, which we recommend most heartily to all lovers of birds, Mr. Heatherley gives some details with regard to his photographic work. He uses a lens with a fifteen-inch focus because he sees no sense in going to the trouble of getting the camera within six feet of a shy bird and then being content with an image the size of a postage stamp. With Kearton, he believes in developing some, at any rate, of his exposures at the end of the day. He has three shutters to his camera: (1) a time and instantaneous one fastened on to the front, (2) a silent studio shutter which he can fix on by taking out the back of the camera, and (3) the most expensive and the least useful—a focal plane shutter at the back. He uses a blackened brass cylindrical hood to screw on the lens in front so as to project two or three inches, which proves useful against sun and rain. He finds a rücksack the most convenient means for transporting apparatus, and the safest,

XUM

because a heavy bag swung over the shoulder is likely to suddenly shift when you are in some awkward situation and shake your nerve, if it does nothing worse.

By the courtesy of the publishers we are able to reproduce on page 395 one of the many excellent photographs with which the book is illustrated.

W. M. W.

A Dictionary of English and Folk-Names of British Birds.—By H. KIRKE SWANN. 266 pages. 8¾-in.×5¾-in. (Witherby & Co. Price 10/- net.)

In this list the accepted English names of British birds are printed in capitals throughout, and under the principal headings there is given much folk-lore and many legends with regard to the more familiar species. Some of the stories are very curious; for instance, the popular belief about the song-thrush is to the effect that the bird acquires new legs and casts the old ones when about ten years old. Another notion, which comes from the Border, with regard to the pied wagtail is that it ought always to wag its tail *nine* times on alighting and before beginning to run about or feed, and should the number be less or more it is very unlucky for the person who is counting. More important from an ornithological point of view is the fact that Mr. Swann gives a reference to the first usage of the various names. Altogether there are nearly five thousand names of all kinds gleaned from literature, from county lists, from several languages and many dialects, and it is obvious that to bring them together, quite apart from the many interesting details that have been added, must have entailed a prodigious amount of work. The time is gone by when the labours of the compiler were not properly recognised, and the value of Mr. Swann's book to all writers upon and students of birds will be acknowledged as very great.

W. M. W.

NOTICES.

ALEXANDER AGASSIZ.—Messrs. Constable will publish almost immediately the "Life and Letters of Alexander Agassiz," edited by his son.

THE FOX.—Mr. J. C. Tregarthen's "Life Story of a Fox," which has gained the admiration of many nature-lovers by the accuracy of its observation and its charming style, is shortly to be issued in a cheaper form by Messrs. A. & C. Black.

THE CENTURY MAGAZINE.—In the issue of this magazine for September, Mr. Robert Sterling Yard, the new editor, reviews the aims of the magazine in the past, and sets forth what they will be in the future. We wish him every success.

UNKNOWN SOUTH AMERICA.—Mr. A. Henry Savage-Landor has been for the past seven months hard at work on his new book, "Across Unknown South America," describing his remarkable journey across that beautiful and virgin continent. The book is now completed and will be published shortly, in two volumes, by Messrs. Hodder & Stoughton.

A NEW NATURAL HISTORY.—For many years Messrs. Cassell have specialised in Nature-study volumes, and the latest addition to their series of books upon this subject will be "Cassell's Natural History," which will deal with all the latest discoveries in Nature Science, and contain photographs taken direct from Nature in natural colours, as well as an abundance of other photographs.

THE NEW ENCYCLOPAEDIA.—Messrs. T. C. and E. C. Jack announce the publication of a new encyclopaedia. The work will be original throughout, and owing to the way in which the matter is condensed and the illustrations treated, the one thousand six hundred pages will contain as much information as is usually put into six large volumes. All the entries are thoroughly up to the latest date, and science is a strong feature of the work. Struck by the inconvenience to the reader of having from a dozen to twenty volumes to choose from, and the consequent confusion and irritation, the publishers have put the whole into one good-sized volume. A large edition has been printed, and the work will be issued at a popular price.

MACMILLAN'S NEW BOOKS.—From the classified list of announcements of new books which Messrs. Macmillan and Company have issued, we find quite a number dealing with anthropology and archaeology. Among these are the two parts of "The Golden Bough," which will complete the third edition of Professor Frazer's great work. In "Marriage Ceremonies in Morocco" Professor Westermarck repairs the omission of which he says he was guilty when he wrote "The History of Human Marriage" more than twenty years ago. We notice also that the first volume of an English edition of Windelband and Ruge's "Encyclopaedia of the Philosophical Sciences" is being brought out under the editorship of Sir Henry Jones. There are besides a number of scientific books which should be of interest to our readers.

BIRKBECK COLLEGE.—We have received the Calendar of the Birkbeck College for 1913–14. Founded by Dr. George Birkbeck in 1823, this institution has played a very great part in the education of the Metropolis, and is now conducted in relation with the University of London. Classes are held both in the day and evening; thirty-two members of the staff are recognised teachers of the University.

The courses of study provide for Degrees in the Faculties of Arts, Science, Laws, and Economics.

In Science there is a very extended curriculum for Chemistry, Physics, Mathematics, Botany, Zoölogy, and Geology. The laboratories are well equipped with modern apparatus and appliances, and research work is carried on in all the departments.

The 91st Session of the College commenced on Monday, 29th September, when the Opening Address was given in the Theatre, at 7 p.m., by Sir Francis Darwin, F.R.S., LL.D., D.Sc.

ARTIFICIAL FERTILISATION.—Dr. Jacques Loeb, head of the department of Experimental Biology in the Rockefeller Institute for Medical Research, has written a companion work to his "Mechanistic Conception of Life," which attracted much attention on its publication last year, entitled "Artificial Parthenogenesis and Fertilisation." It will be issued during the autumn by the Cambridge University Press, as British agents for the University of Chicago Press. The subject of the book is an analysis of the mechanism by which the male sex cell, the spermatozoön, causes the animal egg to develop. The author has gained a world-wide reputation for his achievements in artificial fertilisation, and this work penetrates, in great measure, the mystery which surrounds the term "life" to the extent of showing how the action of well-known chemical and physical agencies may be substituted for that of the mysterious complex called the "living spermatozoön."

ELEMENTARY STUDIES IN ASTROSPECTRA.—In November, Professor Bickerton will commence in "KNOWLEDGE" a series of articles on stellar spectroscopy for beginners. These articles although intended for persons having no knowledge of spectrum analysis, will by simple basic steps lead the student to the solution of problems that eminent astronomers admit themselves unable to explain. They may therefore be useful to all interested in stellar spectra or in the making and reading of even complex spectrograms. By the term "spectrogram" is generally understood a photograph of a celestial object taken by means of a telescope or camera armed with a prism or diffraction grating.

Professor Bickerton has been for many years in New Zealand, where he held a chair in experimental science for over a quarter of a century. The Chairman of the Board of Governors of his College, writing in the New Zealand *Spectator*, of which he is editor, says:—"Professor Bickerton is a man of intellectual power, a most picturesque writer, and above all one who can invest scientific subjects with a literary charm that makes them intensely interesting to the lay mind."

XUM